

Engineering Support Contract Capabilities Awareness



Kennedy Space Center, FL 32899



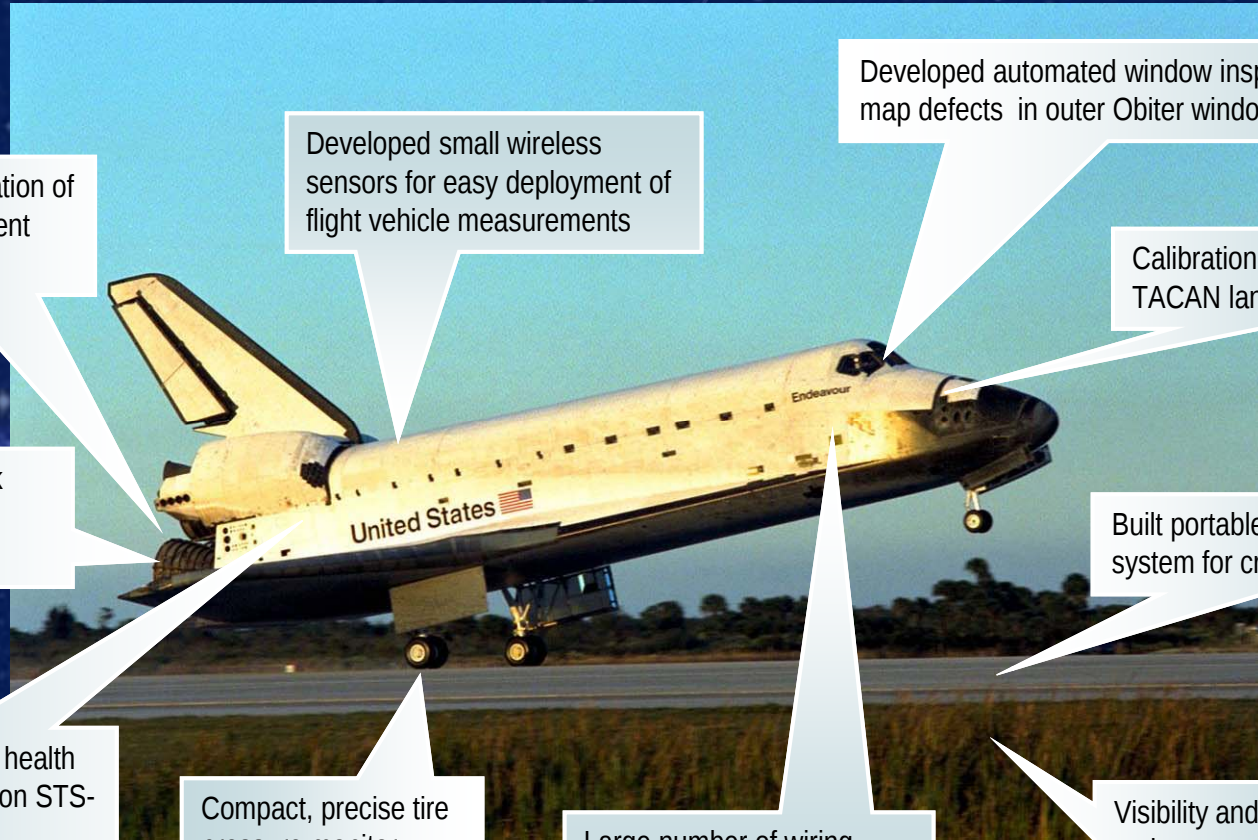
Applied Technology Mission



**Provide applied research, design and development ,
and innovative solutions to our customer's most
technologically challenging needs.**



Shuttle Solutions



Supported investigation of parachute deployment and anomalies

Developed small wireless sensors for easy deployment of flight vehicle measurements

Developed automated window inspection device to map defects in outer Orbiter windows

Calibration of MSBLS and TACAN landing guidance

Invented helium flow leak detector to monitor MPS valve health during flight

Built portable runway weather system for crosswind study

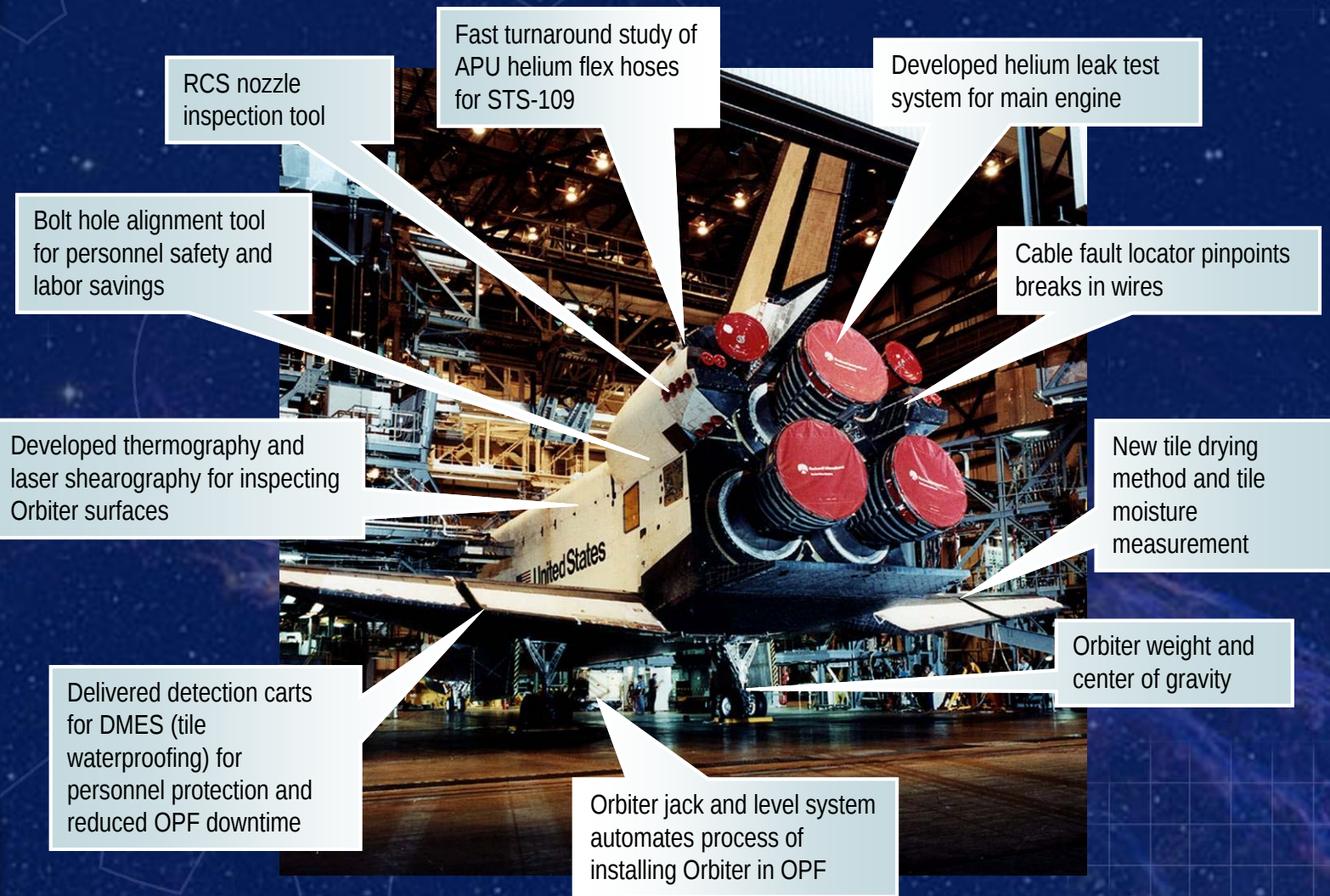
Built and flew vehicle health monitoring prototype on STS-95 and STS-96

Compact, precise tire pressure monitor

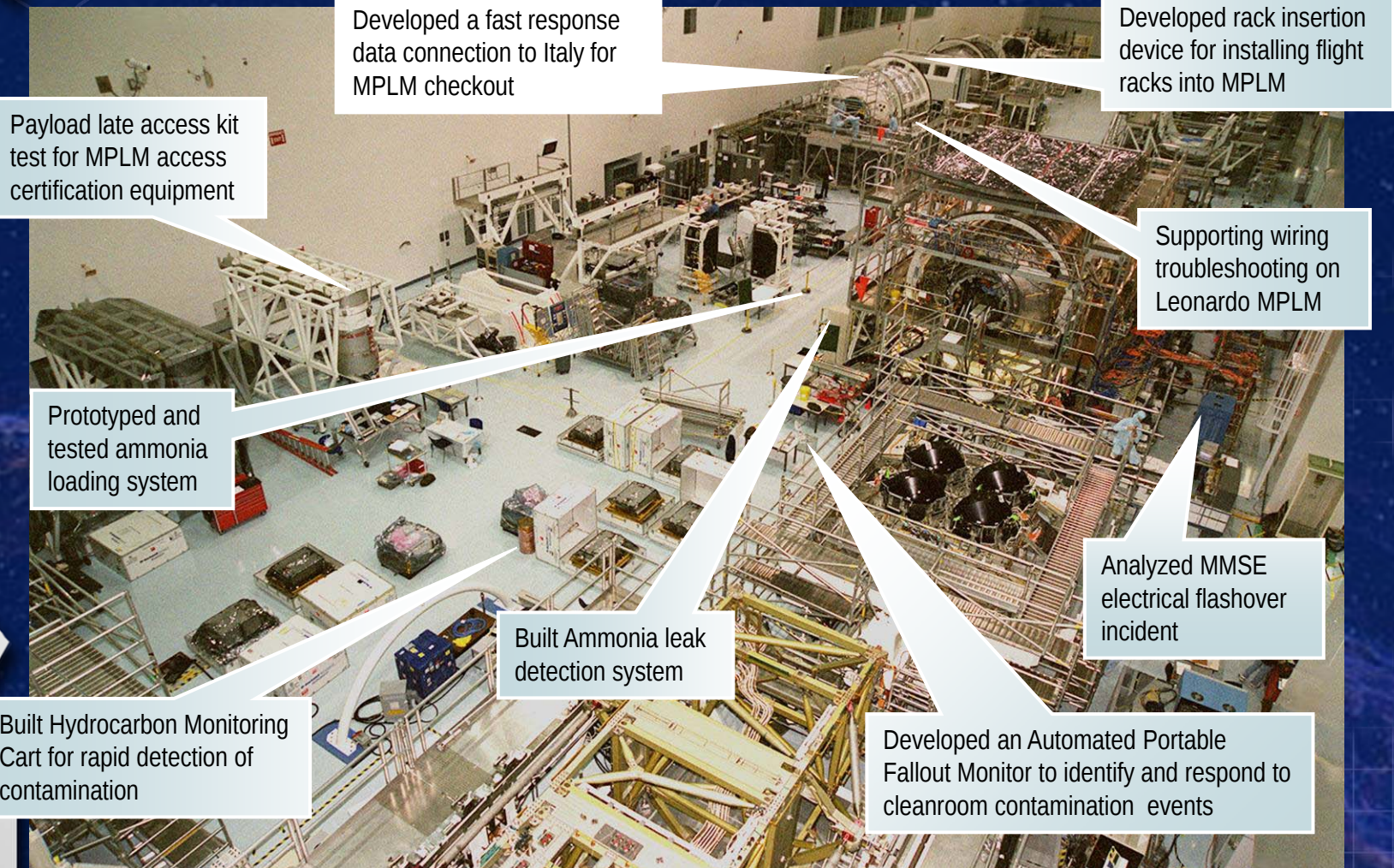
Large number of wiring, connector, and circuit board investigations

Visibility and ground moisture sensors for fog prediction

Shuttle Solutions



Involvement in Space Station Processing



Shuttle Solutions



Upgraded lightning strike detection systems

Developed **Bird Vision System** for monitoring bird activity prior to launch

Developed fail-safe jack screw

Qualified GOX Vent Hood for composite ET nose cone

Developed GOX Vent Hood Alignment Camera

Built "shrimp net" to collect ice from GOX Vent Hood

Automated payload handling, reducing manpower needed

Developed improved stacking alignment tools to streamline operations

Developed cryogenic freeze plug for hydraulics to replace component at pad

Developed new hydrogen and oxygen leak detection systems, improving flight safety

Calibrated and performed special tests on holddown posts

Qualified new hypergolic flow meters, reducing maintenance

Invented new technologies to replace data acquisition system, saving labor

Tested improved corrosion-resistant coatings for launch pad structures

Developed fiber-optic monitoring system, avoiding purchase of new equipment

Applied Technology Laboratories



Applied Chemistry Laboratory

Polymer Science and Technology Laboratory

Electrostatics and Surface Physics

Cryogenics Test Laboratory

Corrosion Technology and Engineering Laboratory

Applied Physics Laboratory

Advanced Electronics Laboratory

Granular Mechanics and Regolith Operations

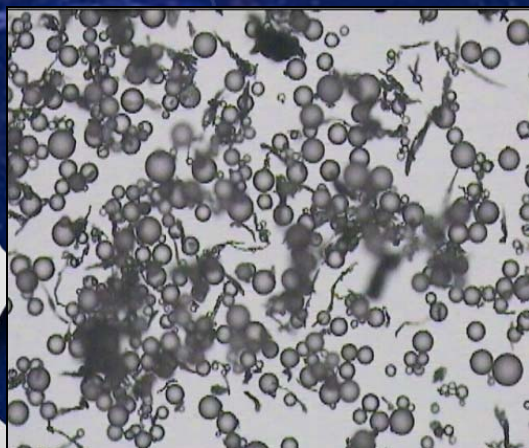
Range Technologies Lab

Non-Destructive Evaluation (NDE)

Lightning Detection & Analysis

Expertise

Expert skills in polymer chemistry, analytical chemistry, physical chemistry, advanced materials, fluorescence, organic synthesis, laser spectroscopy, electrochemistry, analytical instrument development/testing, fabrication, machining, mathematical modeling, and software development. Technology development in toxic vapor detection, chemical scrubbers for toxic waste, microencapsulation of materials for space applications, hypergolic fuel dosimetry, hydrogen detection, self-healing wire insulation, minimally intrusive repair methods for electrical wiring, and environmental remediation



Wire Damage Detection System

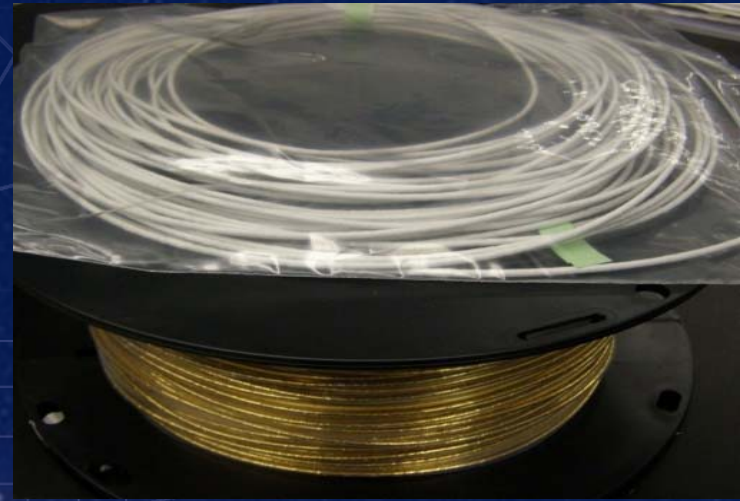


New wire construction allows the detection of wire insulation damage before damage reaches core conductor

Fault detection currently utilizes time domain reflectometry (TDR)

Miniaturized in-line TDR system developed as part of detection system

System will locate damage on powered or unpowered cables (current state-of-the-art requires wire to be unpowered)



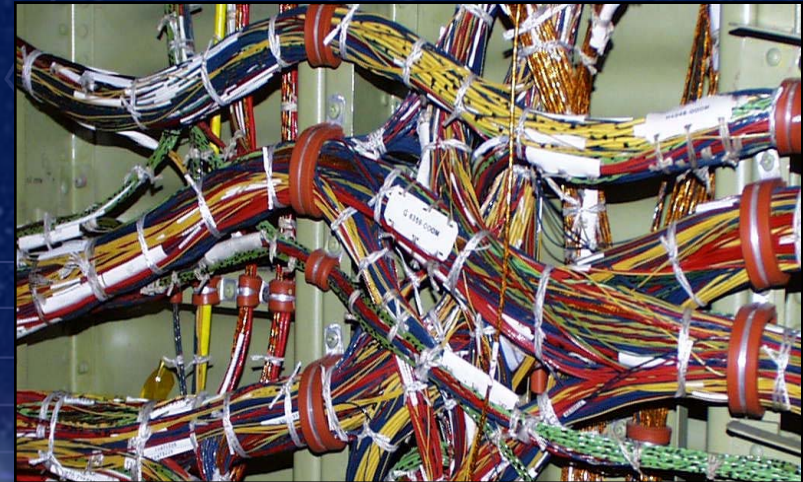
Manual Wire Insulation Repair



**Minimally intrusive manual repair
for polyimide and fluoropolymer
wire insulation**

**Samples evaluated for chemical,
mechanical, and electrical stability**

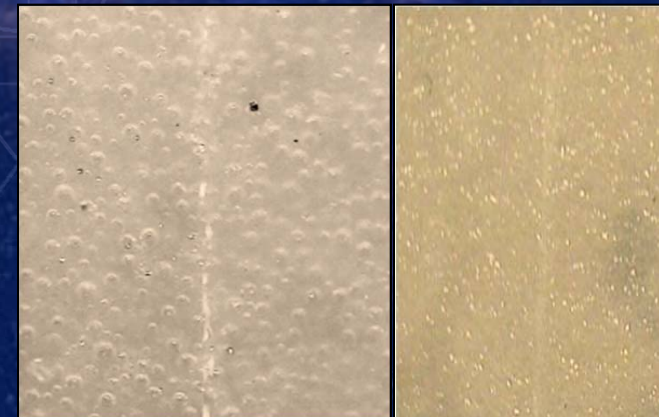
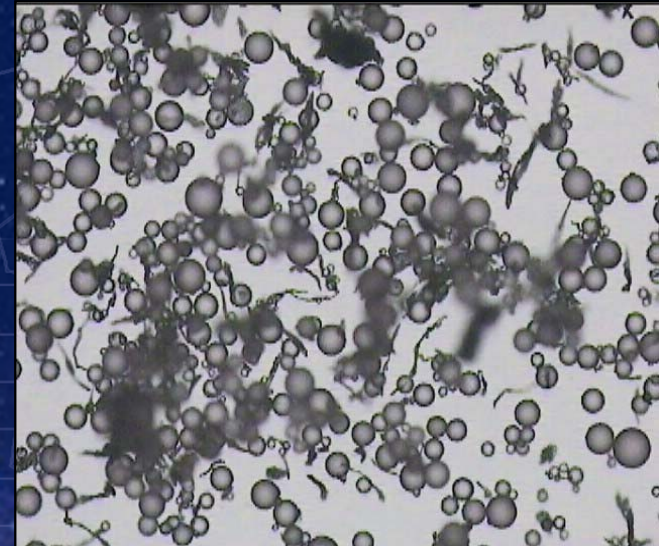
**Proof-of-concept repair kits being
developed and will be evaluated by
the Naval Air Command (NAVAIR)**



Developing advanced concepts related to the formation of self-healing, flexible materials

Evaluating various methodologies to produce microcapsules with high aspect ratios (HAR) to determine impact on microcapsule flexibility

Evaluating chemical, mechanical, and electrical properties of self-healing, flexible materials



Developed technologies that allow the detection and capture of water and hydrogen on the lunar surface

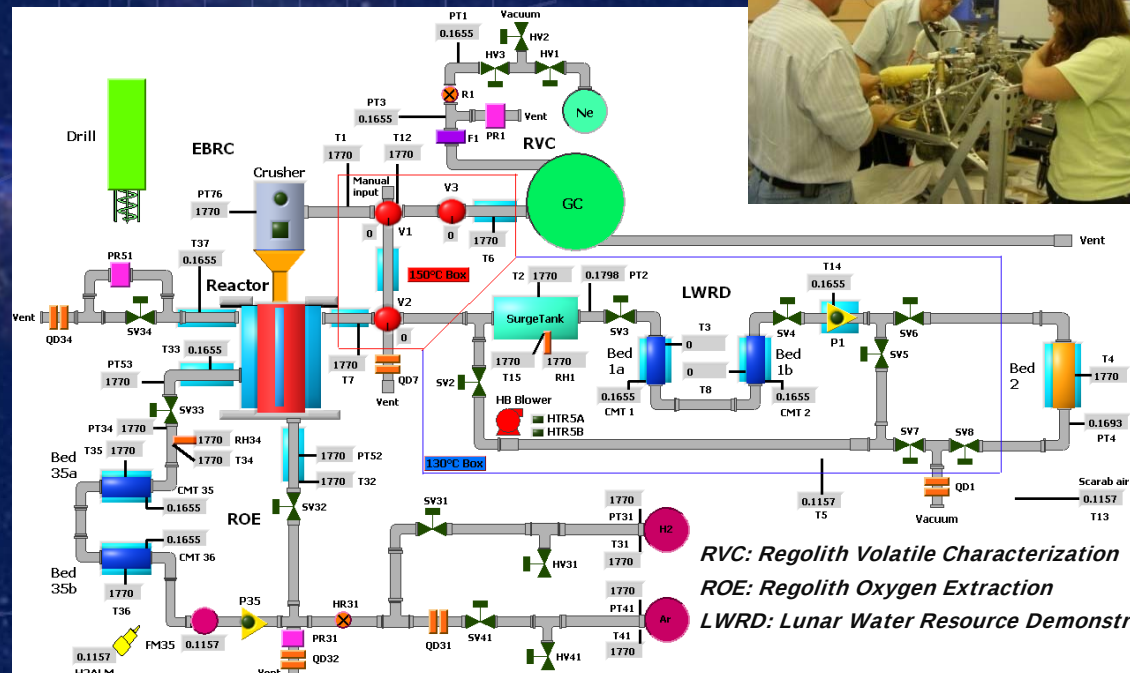
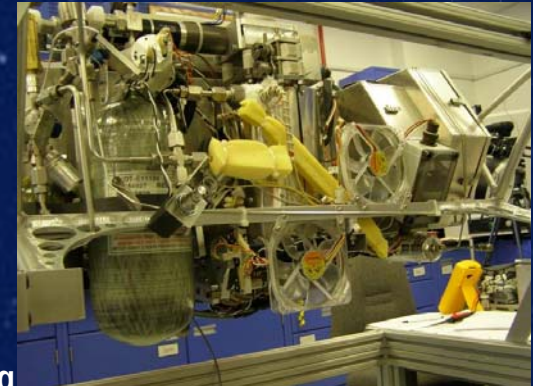
Second generation engineering breadboard unit (EBU-2) was built

Teamed with NASA Johnson, NASA Glenn, Norcat, and CMU

EBU-2 was computer monitored and controlled allowing autonomous operation

EBU-2 was integrated into a rover and attached to a drilling/crushing system

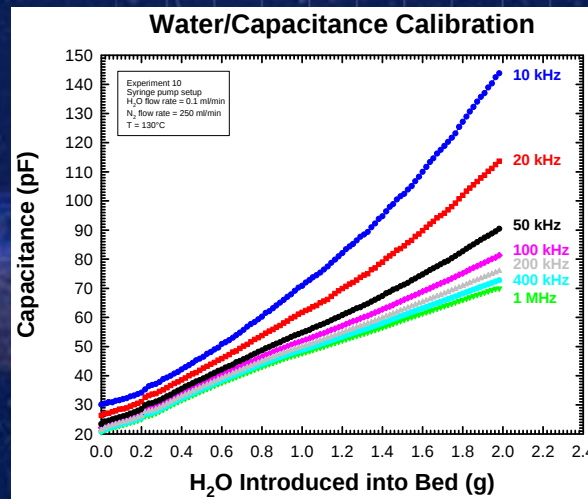
The integrated unit was tested successfully on Mauna Kea in Hawaii



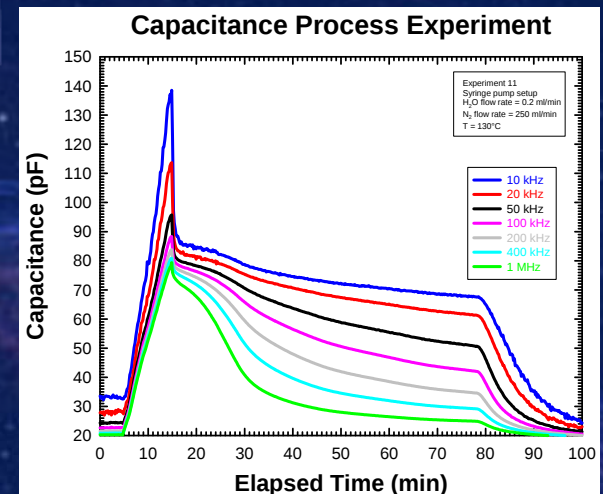
Water Beds and Capacitance Sensors

Concentric capacitance sensors are designed into the desiccant-filled beds to measure water concentration

Water beds and sensors are optimized for maximum water capture, minimum weight, and excellent capacitance response



Linear response at high frequencies (mainly dipolar motion) yields an excellent, reproducible calibration curve

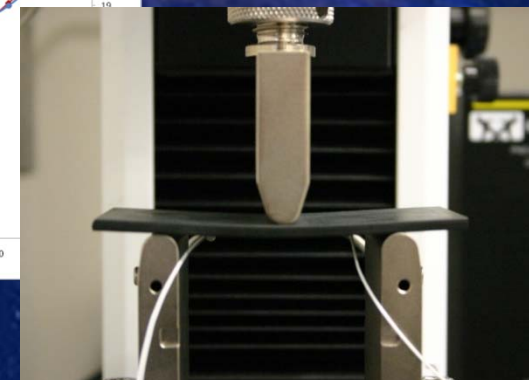
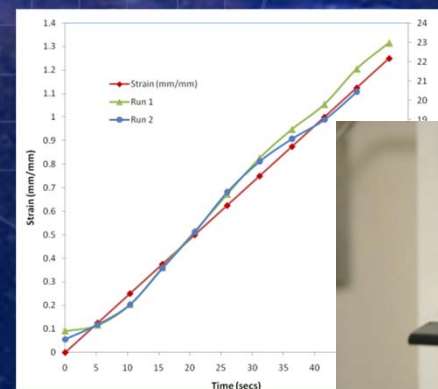
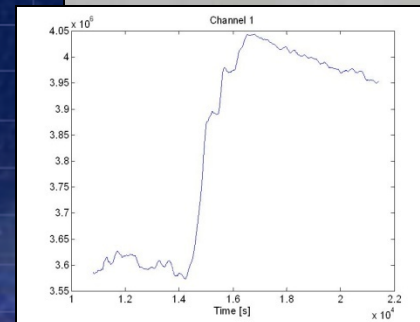
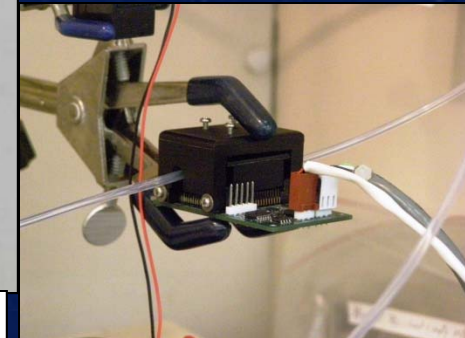


Sensor was used to measure all aspects of the process – background, absorption, desorption, and cooling

Carbon nanotube based sensor developed by ASRC and Ames Research Center (ARC) Sensor capable of detection down to 10 ppb hypergolic fuel

Sensors have been evaluated using hypergolic fuel and oxidizer, as well as ammonia and isopropyl alcohol

Sensors have been developed to monitor the strain of composites



Polymer Science and Technology Laboratory



The Polymer Science and Technology Laboratory (PSAT) provide expertise and training in polymer chemistry, thermal insulation materials, inherently conductive polymers, composite materials, nanocomposites, radiation shielding materials, fire and polymers, thermal degradation of polymers, contact electrification of polymers, electronic devices, antimicrobial polymers, sandwich structures and composites design and manufacture, and cryogenic engineering for the aerospace industry



Notable Achievements

Developed composite materials which change color upon exposure to Hydrogen gas.

Developed an Ice mitigation coating for both LOX and LH2 umbilicals in collaboration with NASA/NESC.

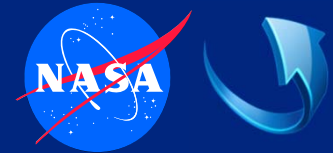
These coatings have achieved a 90% reduction in ice adhesions.

Filed 7 full and 4 provisional patents since 2005 (1 awarded)



- **RESOLVE**
- **Capacitance Sensors**
- **Membrane Water Separation**
- **Lunar Oxygen Production by Electrolysis**
- **Manual Wire Insulation**
- **Electrostatic Benefication**
- **Lunar Greenhouse Amplifier**
- **Monitoring and Control**
- **Laboratory Equipment**
- **Other Projects**

Electrostatics and Surface Physics Laboratory



Conduct electrostatic analyses and materials characterization to assist in the detection, mitigation and prevention of electrostatic charge generation on space flight hardware and ground support equipment.

Involved in dust mitigation efforts for lunar and Martian exploration and methods for planetary protection



Electrostatics and Surface Physics Laboratory



Expertise

- Scientists and engineers with advanced degrees in physics, materials science, and electrical engineering, with specialist skills in electrostatic testing and prevention, tribocharging properties of materials and surface science.
- 2 Ph.D.s in Physics and Materials science 1 M.S. Space Sciences
- Members of the Space Shuttle's Electromagnetic Environmental Effects Panel

Facilities/Capabilities

Electrostatics Measuring Equipment

Optical Emission Spectrometer

Three Large Environmental Chambers

Field Emission Secondary Electron Microscope

Atmospheric Plasma Glow Discharge Sources

X-ray Photoelectron Spectroscopy

Atomic Force Microscopy

UV Source and Monochromator

Spark Incendivity Testing

Static Ignition Hazardous

High Vacuum Testing

Thin Film Deposition

High Voltage Testing

Triboelectric Testing

Charge Decay Testing

Contact Angle Measurement

Electrostatics and Surface Physics Laboratory



Notable Achievements

Leading ESD experts for the Space Shuttle , International Space Station and Expendable Launch Vehicle Programs for NASA

Developed state-of-the-art non-mechanical Dust Removal Systems for space hardware

First to fully characterize the electrostatic properties of Apollo 14, 16, and 17 lunar regolith

First to use Electrostatic Beneficiation of Apollo samples for In-Situ Resource Utilization (ISRU)

Solved ESD issues for replacement circuit boards for the Hubble telescope repair mission

Solved critical ESD issues for the Space Shuttle and Station blankets, curtains and purge barriers

First to use Electrostatic Precipitation for removal of contaminants in high-pressure GN_2 lines



Electrostatics and Surface Physics Lab



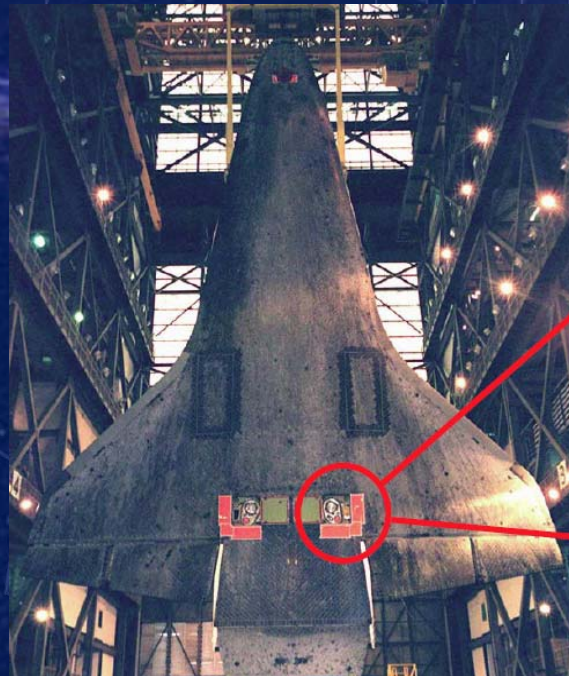
Large UHV chamber

Electrostatics Testing for Safety



The Electrostatics and Surface Physics Laboratory solves a variety of ESD problems for NASA. All involve extensive testing and notable examples are:

- Ares I-X outer skin resistivity
- Space Shuttle and Space Station Thermal control system blankets
- Ground Support Equipment Aclar Purge Barrier
- Kapton Purge Barrier Curtain
- Hubble Repair Mission ESD concerns

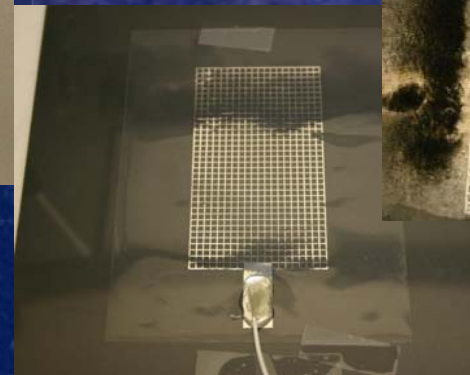
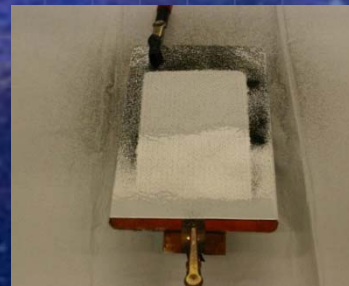
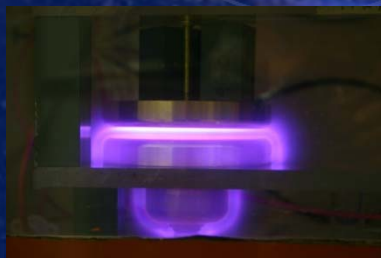
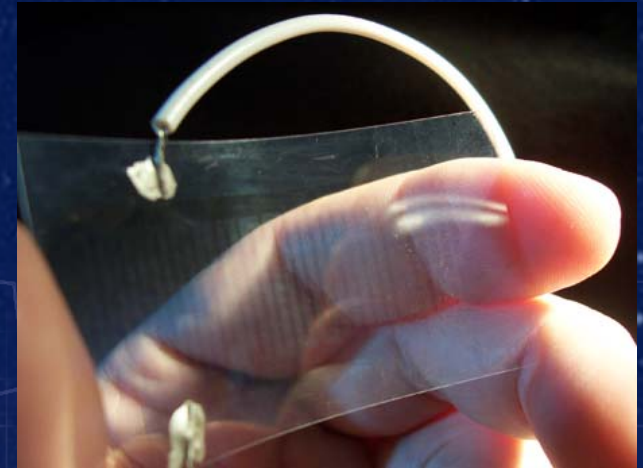


Using Electrostatics to Solve Problems



Electrostatics **SOLVES** several problems for a variety of industries: toner industry, pharmaceutical industry as well as the aerospace industry. The ESPL uses electrostatics to:

- Provide self-cleaning surfaces with no moving parts
- Remove particles contaminants from gas flow
- Govern the behavior of lunar dust particles for mineral separation
- Electrostatics may be the reason life does not exist on Mars



Dust Mitigation on Fabrics Using CNT Links

Effects of Triboelectric Charging on Mars

Characterization on Lunar Materials

RESOVLE Electrodynamic Screens

Hubble Space Telescope Repair Mission Concerns

One-of-a kind capability for research, development, and application of cross-cutting technologies to meet the needs of industry, government, and research institutions. We provide cryogenic expertise, prototype construction, experimental testing, engineering evaluation, and practical problem-solving for technology development with NASA, government, and commercial partners. thermal insulation systems, cryogenic components, propellant process systems, and low-temperature applications



Cryogenic Moisture Uptake (CMU) Apparatus



Specialized Services

Materials characterization and analysis

Thermal conductivity testing under real-world conditions

Thermal performance testing of cryogenic piping systems and tanks

Development of materials for engineered applications

Experiment design and prototype construction

Engineering thermal analysis



Ground Umbilical Carrier Plate
(GUCP) Shroud Testing

Our overall objective is to develop materials, produce new technology and promote engineering for energy-efficient storage, transfer and use of cryogens and cryogenic propellants on Earth and in space.

Expertise

Expert skills in cryogenic engineering, cryogenic applications, thermodynamics, design, analytical chemistry, physical chemistry, advanced materials, analytical instrument development, testing, fabrication, machining, mathematical modeling, and software development.



Over 260 years of Cryogenics
Experience



Rapid Propellant Loading Test System
0-900 GPM Cryogenic Test Bed

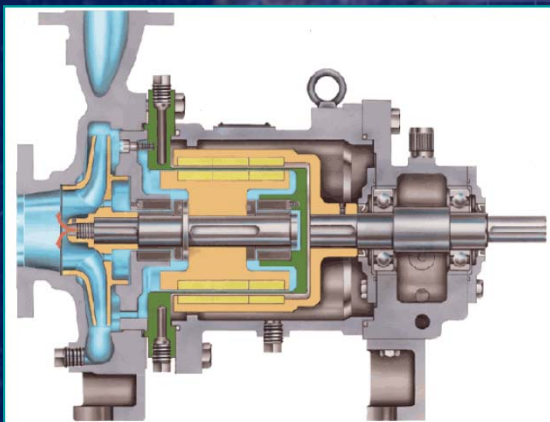
Magnetically Coupled Cryogenic Pump



Magnetically close coupled pumps are highly reliable and eliminate potential leak paths, sources of contamination or ignition and also remove maintenance items.

Use of these pumps with cryogenic fluids are beneficial for all of these reasons, but there are currently no commercially available pumps for use with cryogenics.

A commercially available magnetically coupled pump was procured, internally modified and tested with liquid nitrogen.

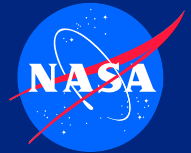


Alternate bearing and bushing materials were tested and clearances adjusted to prevent binding of the components.

Successful pumping of cryogenics was accomplished after modification of the pump components.

Larger scale pump is being developed for use in liquid oxygen.

Space Shuttle Ground Umbilical Carrier Plate (GUCP) Testing



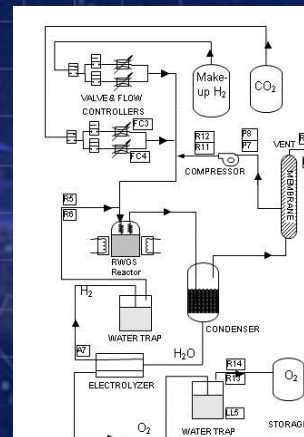
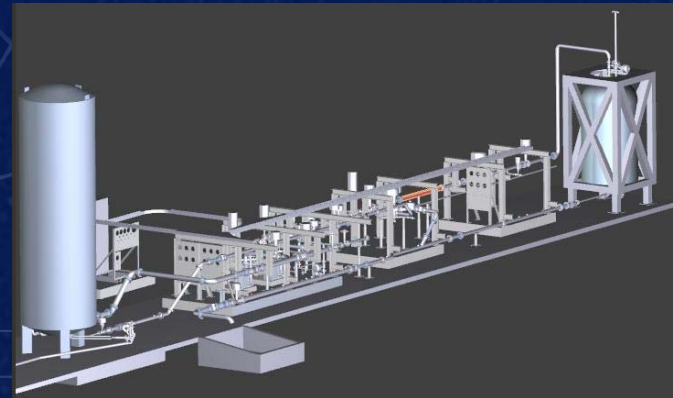
Test for leaks around GUCP seal at cryogenic temperatures to determine sources of leak during STS 119 launch countdown operations on 03/11/09.



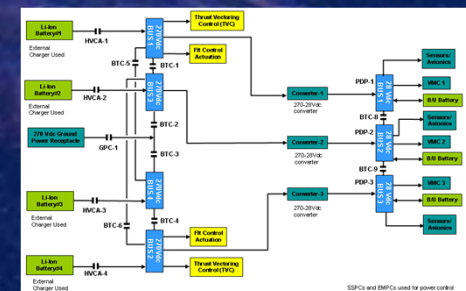
Model-based Diagnosis (MBD)



- Software capability to recognize and adapt to failures in physical hardware
- Advise operators of equipment faults and workarounds
- Recover from faulty conditions via redundancy and reconfiguration
- Useful for operator training, control advisories and Single-point Failure analysis
- Generic MBD software + hardware model = comprehensive diagnostic capability

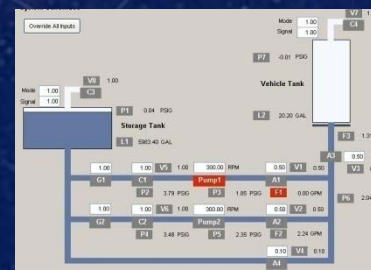


- Hardware model is easily constructed from a library of standard GSE and flight hardware components



Applications:

- Rapid Propellant Loading
- Lunar Oxygen plant control
- Thermal management
- Electrical Power Distribution
- Environmental control



Rapid Cryogenic Propellant Loading Systems

Notable Achievements

In Situ Propellant Conditioning

Chilled Helium Heat Exchanger

Consumables Transfer Technology Development

STS-119 / ET-127 GH2 Vent Cryo Leak Test

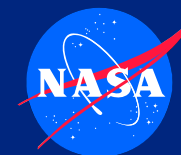
Pad 39B LH2 Block Valve Refurbishment Techniques

Helium Conservation Testing

The Corrosion Technology Testbed at the Kennedy Space Center has evolved from a need to better understand the processes that degrade our launch sites to a state-of-the-art problem solution center. At the heart of the Testbed is an atmospheric corrosion test site, which was established in the 1960s and has provided over 40 years of historical information on the long-term performance of numerous materials.



Corrosion Technology and Engineering Laboratory



Expertise

Laboratory staff includes scientists, engineers, and technicians with advanced degrees and expertise in Chemistry, Analytical chemistry (3 Ph.D), Chemistry 2 BS and an Engineering Aide

Laboratory Services

Accelerated Corrosion Testing
Seawater Immersion
Electrochemical Evaluation
Coatings Application
Surface Analysis – Field Emission Scanning
Electron Microscope with Energy
Dispersive Spectroscopy (SEM/EDS)

Atmospheric Exposure Site

Continuous online monitoring of temperature, humidity, wind speed, rainfall, total incident solar radiation, and UVB radiation. Real-time data acquisition and internet based viewing of samples.

On site Corrosion Laboratory

Electrochemistry Laboratory

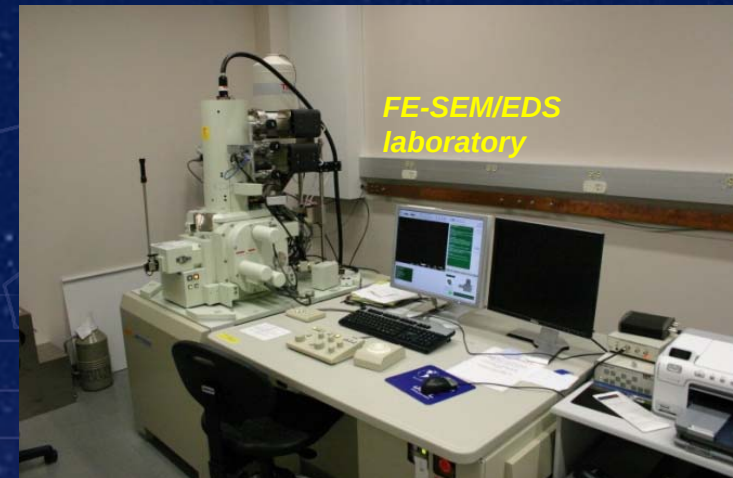
State-of-the-art instrumentation and equipment for corrosion measurements including direct current (DC) and alternating (AC) current methods.



Beachsite laboratory

Representative Projects

- Smart Coating Development (NASA)
- Self-Cleaning Coatings (NASA)
- Corrosion Resistant Tubing for Shuttle Launch Sites (NASA)
- Galvanic Coatings for Protection of Steel in Concrete (NASA)
- Cost of Corrosion Study (DoD)
- Chloride Rinse Agent Investigation (Army)
- Polyurethane Replacement Coatings (NASA)
- Evaluation of Corrosion Mitigation techniques for Flight and other Critical Space
- Station hardware (NASA)
- Coatings support for Exploration and Spaceport Design (NASA)



Vehicle Coating Study

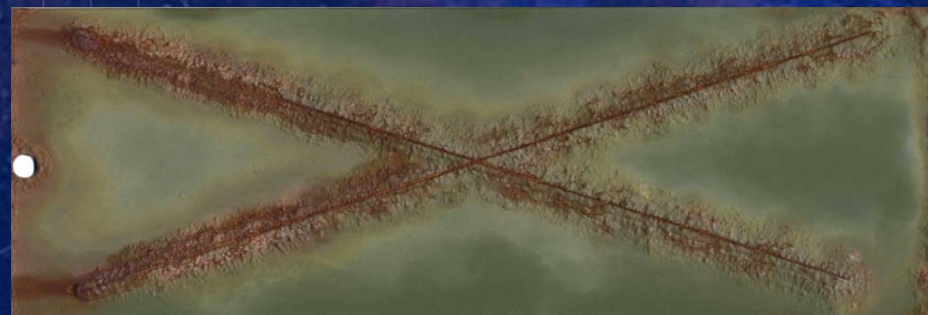
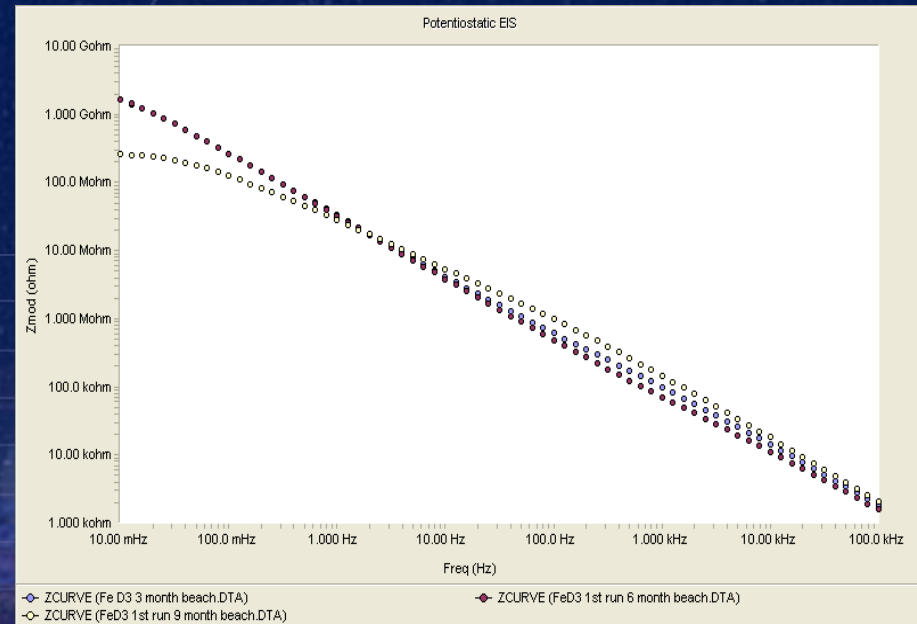


Evaluated the physical properties of four coating systems. The properties included:

Gloss
Color
Corrosion Resistance

Evaluated the performance of the coating using Electrochemical Impedance Spectroscopy

Compared the physical and electrochemical properties with a similar set that is exposed to ASTM B117 salt spray at the Army Research Laboratory.



Successfully Synthesized Microcapsules

Break down under corrosion conditions

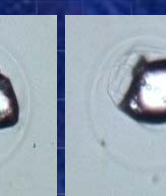
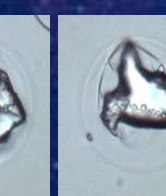
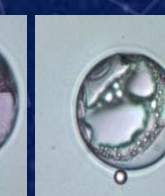
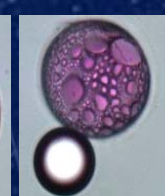
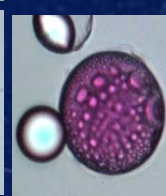
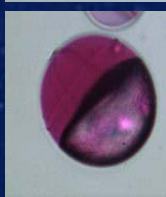
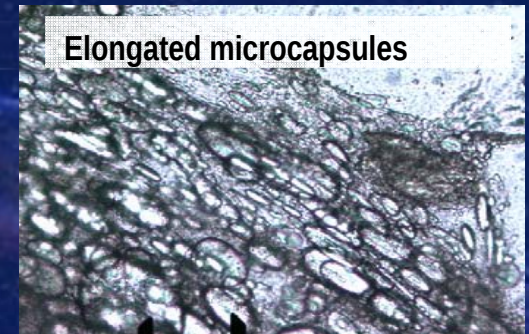
Contain Corrosion indicators and inhibitors

Elongated for self healing function

Indicator encapsulated



Elongated microcapsules



In-Situ Phosphatization for KSC Coatings and Corrosion Preventative Compounds

Flame Deflector Protection and Corrosion Control

Lunar Simulant Sintering Process Evaluation

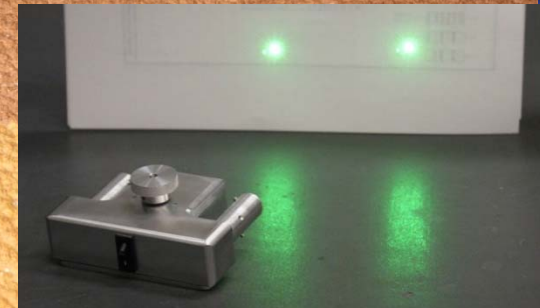
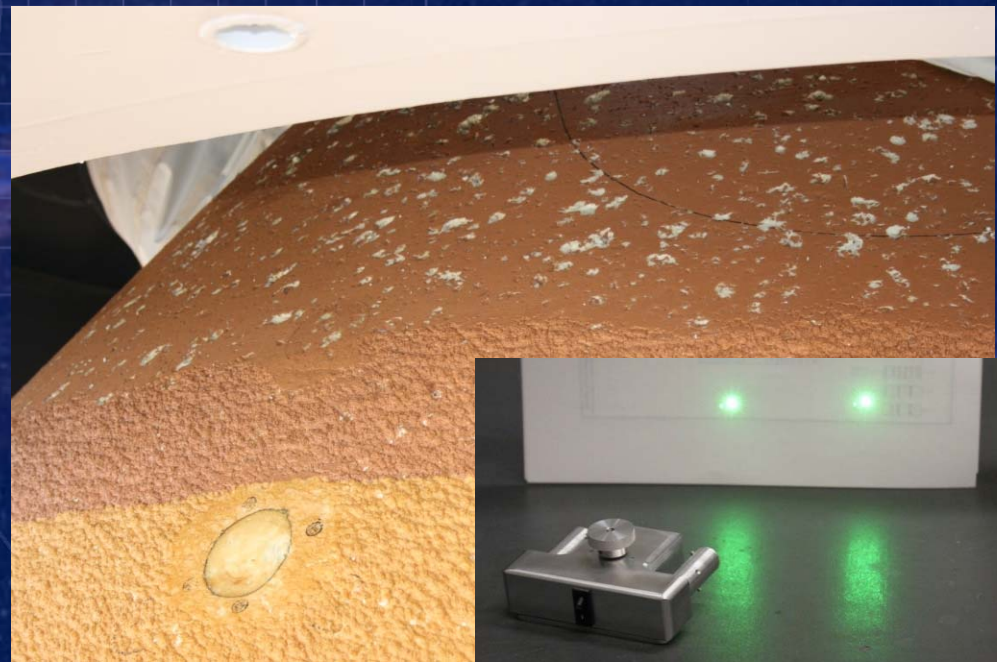
Sintering Methods for Building a Lunar Launch Pad

LC39A Flame Trench Firebrick Adhesion Testing

An Analysis of Coating Degradation for the U.S. Army Research Laboratory

The Applied Physics Lab develops and tests technologies involving:

- Optical systems
- Unique measurement systems
- Applied Physics
- Applied Thermodynamics
- Applied Mechanics
- Electro-magnetics
- Machine vision
- Image processing
- Photogrammetry



The Applied Physics Laboratory is a technology response lab specializing in applied physics. The laboratory receives problems primarily from Shuttle operations and sometimes from the Expendable Launch Vehicle program, Space Station, payloads and Constellation. The lab attempts to take demonstrated concepts that can solve a problem and turn them into a field worthy hardware.



Lab Expertise:

Applied physics, thermodynamics, and mechanics to solve specific flight hardware processing problems.

Develops and tests technologies involving optical systems

Nondestructive evaluation (NDE) expertise

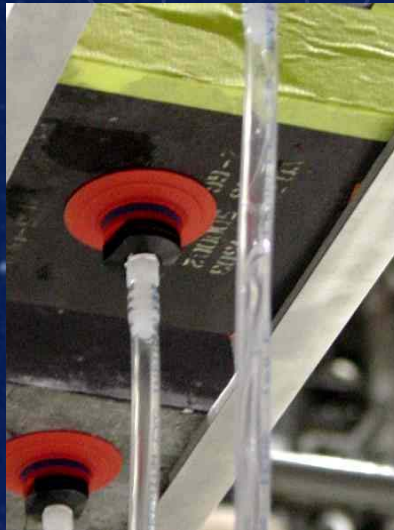
Unique measurement, tracking and visualization systems (Photogrammetry)

Electromagnetics expertise

3D laser scanning and modeling



Orbiter Tile Water Detection & Removal

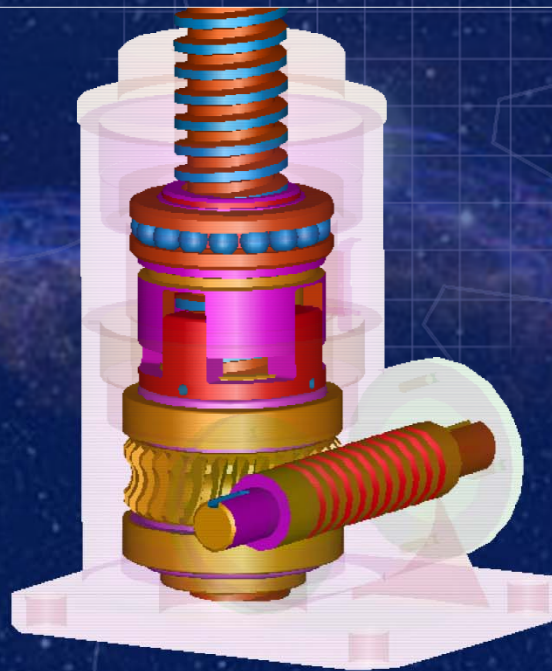


Orbiter Tile Water Detection and Removal resulted in no schedule impact and saved the program \$M

Failsafe Jackscrew



Failsafe Jackscrew design
provides a redundant nut
on critical applications



Shuttle Shop Aids

SRB Tools

Access and Handling Systems

Hail Monitor

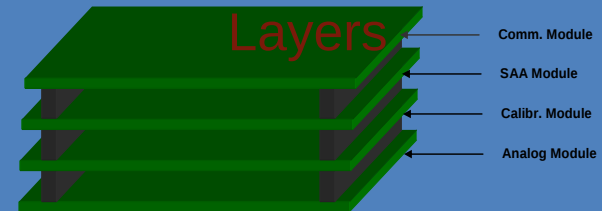
NDE Techniques for Composite Fairings

Bird Vision

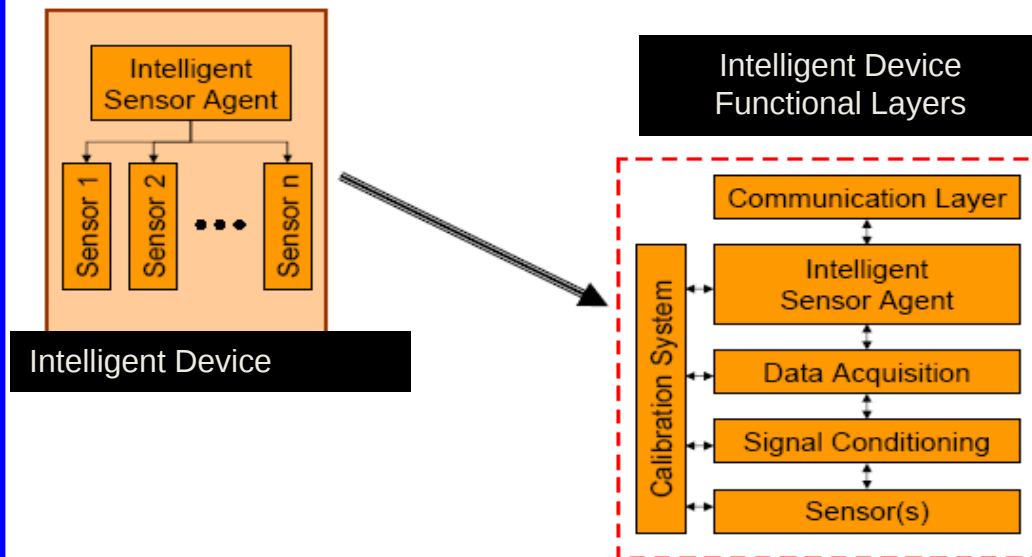


- Data Acquisition & Instrumentation
- Smart Sensor Development
- Custom Electronics Design
- Embedded Systems
- Signal Conditioning

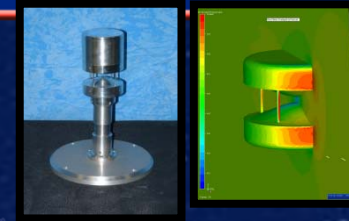
Intelligent Device Physical Layers



Intelligent Device Architecture



3-D Venturi Hurricane Wind Sensor
(Multi-sensor, multi-disciple array, smart algorithms)



Self Validating Thermocouple Sensor
(smart algorithms)

Cabin Pressure Monitoring System
(multi-sensor, smart algorithms)

Year 2000, U.S. Patent # 6,452,510



**Intelligent
Sensors**

Wireless Sensor Network
(multi-sensor, smart algorithms)

Year 2003, U.S. Patent # 7,274,907



NIST Traceable Pressure Transfer Standard
(multi-sensor, smart algorithms)

Vacuum Jacketed Lines (VJ) Wireless Sensor
Network
(multi-sensor, smart algorithms, automation)



Smart Cryogenic Level Sensor (tolerance)





Orbiter Tire and Strut Pressure Monitor
(TPM)
(multi-disciple sensors, smart algorithms)



Intelligent Cable Tester
(smart algorithms for failure detection)



Year 1996, U.S. Patent # 5,894,223, 5,977,773



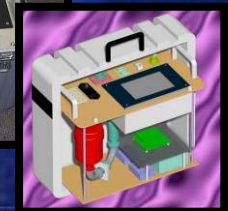
Intelligent Tools

External Tank Centering and Alignment
(smart algorithms, wireless system,
hazardous environment)

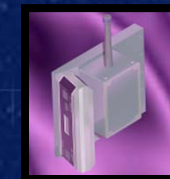
Year 2002



VJ Wireless Sensor In-Situ Calibration Station
(smart algorithms, wireless system, hazardous environment)



Orbiter Hang Angle Wireless Inclinator
(smart algorithms, wireless system, hazardous
environment)



Real-Time Calibration Method For Signal-Conditioning Amplifiers

Year 2002, U.S. Patent # 6,801,868

Extreme Velocity Wind Sensor (EVWS) Wind Speed and Wind Direction Determination Algorithm.

Piece-wise Linearization of Analog-to-Digital (A/D) converters for Highest Accuracies

Intelligent Algorithms

Smart Power Management Scheme for High-Reliability Electronic Circuitry

Wireless Vacuum Jacketed (VJ) Fault-Tolerant Instrumentation Software

Embedded Process-Knowledge In Sensors

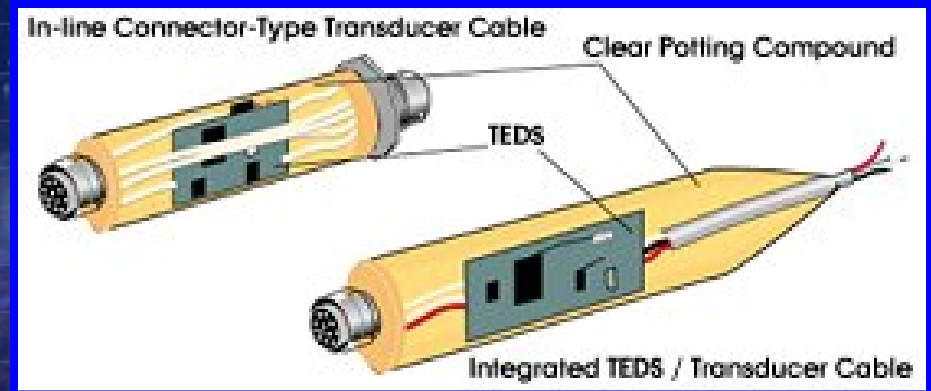
Universal Signal Conditioner



When transducers are calibrated, a small memory contains information required by the USCA to configure itself.

- Transducer type
- Excitation level
- Output voltage range
- Linearization coefficients
- Measurement ID number
- Digital filtering
- Sampling rate

Year 1995, U.S. Patent # 5,734,596



USCA is a self-calibrating, programmable device which performs real-time signal processing. The device configures itself for operation based on information stored in an electronic data sheet.

MSA is a fault-tolerant transducer architecture designed to increase measurement reliability and extend traditional calibration cycle times



Year 2001, U.S. Patent # 6,757,641

Array of MEMS sensors and KSC developed software algorithms. Embedded electronics provides autonomous self-calibration and health checks.

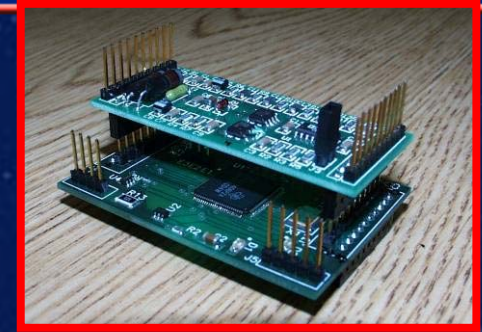
Valve Health Monitor



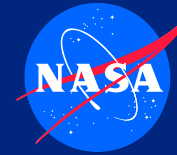
Valve Health Monitor is a non-invasive transducer, with embedded process-knowledge capability to detect valve's electromechanical anomalies, degradation and/or failures. Ultimately, it provides failure trending and prediction

Year 2000, U.S. Patent # 6,917,203

Present implementation combines Hall Effect technology with KSC developed diagnostics algorithms to perform valve health determination. Embedded electronics provides autonomous self-calibration and health checks



Granular Mechanics and Regolith Operations



Support surface system requirements for the Moon and Mars by utilizing ground systems development expertise to provide innovative concepts for the development of surface infrastructure such as servicing systems, site preparation, and other support equipment.



Expertise

Lab specializes in the mechanics of soil and other particulates through analysis, testing, and numerical modeling capabilities. Primary focus is to solve powder and granular material technology problems for Shuttle, Crew Exploration Vehicle and In-Situ Resource Utilization. Many powder and granular material are used in spacecraft processing and present a range of technology challenges.

Laboratory Services

- Soil mechanical and geotechnical support to KSC,
- Powder mechanics and granular mechanics,
- Rocket cratering effects in Lunar and Martian soil,
- Lunar soil mechanics and excavation for ISRU,
- Rocket exhaust plume effects on lunar soil, and
- Lunar and Martian spaceport site preparation.



Lunar Landing Support



For Constellation, will be landing in same location: need to know lunar soil ejection angle from jet impingement to protect equipment

Particle Ejection and Levitation Technology (PELT) is to develop instrument to measure 3D flow field of regolith ejection under lander

Image analysis for rocket cratering

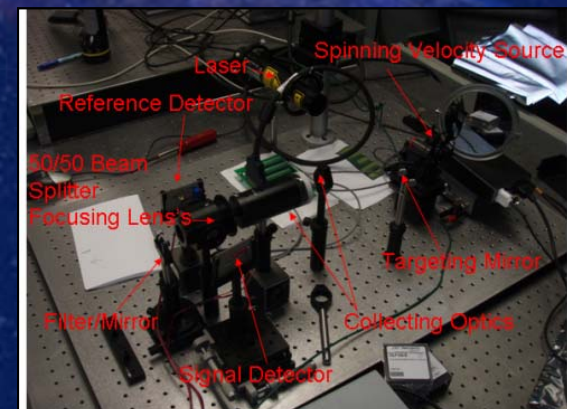
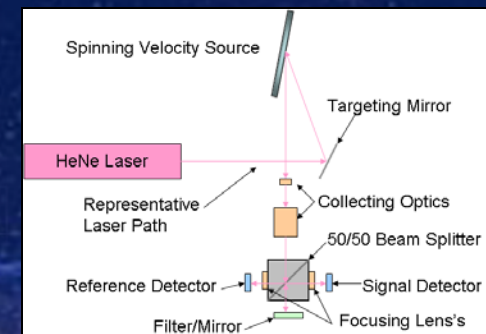
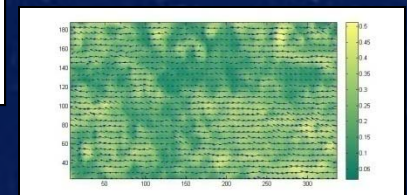
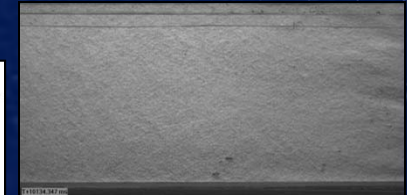
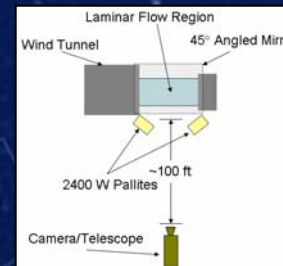
Two technologies were developed, Particle Image Velocimetry (2D), Particle Doppler Velocimetry (1D)

PIV successfully measured flow in wind tunnel at 130 feet

PDV innovative development: unique Doppler filter made of 3d volume Bragg grating

Project advancement PIV: TRL 0 to TRL3, PDV: TRL 0 to TRL 1-2

Targeted for installation on Altair and/or Google X-prize landers

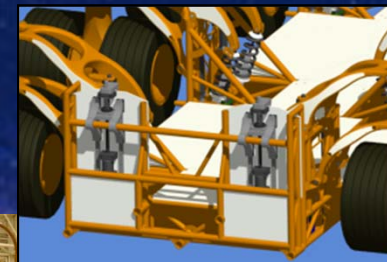


Lunar Surface Excavation Hardware

Design and development of the Chariot Lunar Rover Implement Attachment Mechanism. The implement attachment mechanism will provide an un-manned ability to mate and de-mate implements such as the LANCE blade, astronaut platform, and science toolkits.

Design and development of the carbon composite lightweight LANCE blade. Currently designing modifications to the LANCE blade which will include the implement attach interface as well as EVA manual height adjustment.

Collaborating with GRC on an excavation system for supplying regolith to an ISRU O_2 reactor for demonstration at D-RATS '10.



Lunar Regolith Conveyance Systems



Mechanical Conveyance System

Designed and developed mechanical hopper and auger designed regolith conveyance system for Roxygen system.

Successfully assembled and tested the subsystem at JSC to qualify for the OPTIMA Field Test

Assembled the complete system in Hilo for the OPTIMA Field Test

Successfully performed reductions to achieve the goal of producing water from dry native soil and separating that water into hydrogen and Oxygen gasses.



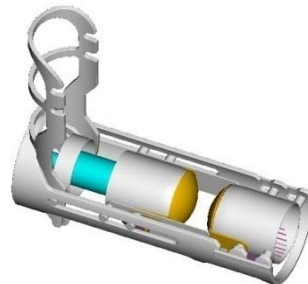
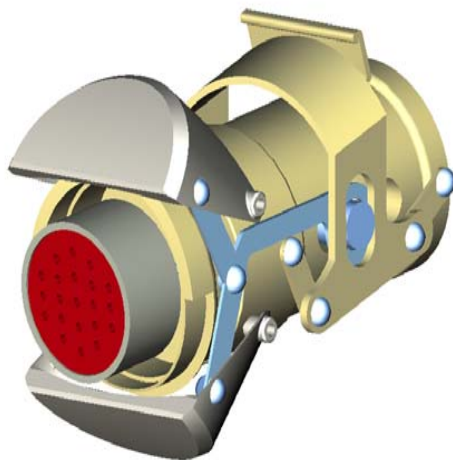
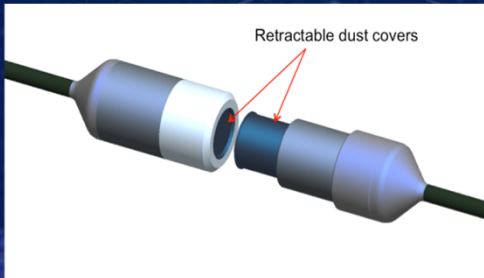
Pneumatic Conveyance System

Currently designing phase II pneumatic system

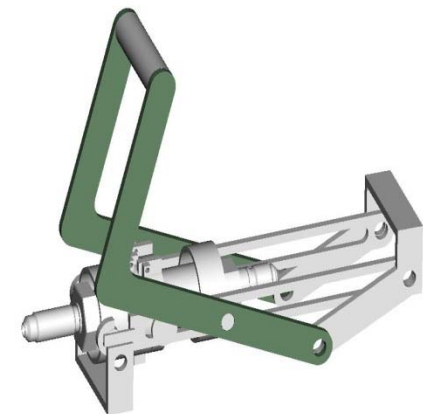
Lunar Dust Tolerant Connectors



- Fluid Connectors
- Electrical Connectors
- Dust tolerant housings



XX+0.1
XXX+0.01
XXXX+0.001
ANG: +0.5



XX+0.1
XXX+0.01
XXXX+0.001
ANG: +0.5



Develop, test, and demonstrate advanced space communication systems technologies that support safe and efficient range operations for Vehicle and Debris Tracking, Automated Flight Termination, Telemetry and Communications

Expertise

This lab provides expertise in support of range systems, specializing in design and integration of analog and digital electronic systems, telemetry, microwave through millimeter wavelength electromagnetic solutions, antennas, and RF/Optical /wireless communication systems.

Laboratory Services

Next-generation range instrumentation development using GPS satellite simulators and tracking and modeling software

Development and testing and installation of autonomous GPS-based landing systems

Development and demonstration of communication systems for range applications: IRIDIUM; and Tracking and Data Relay Satellite

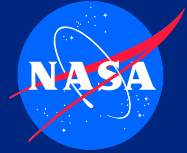
Next generation launch vehicle flight tracking and termination systems using GPS and INS onboard navigation software

Application of GPS navigational signals to the calibration of landing aid systems and navigation

Development of advanced RF and range communication systems



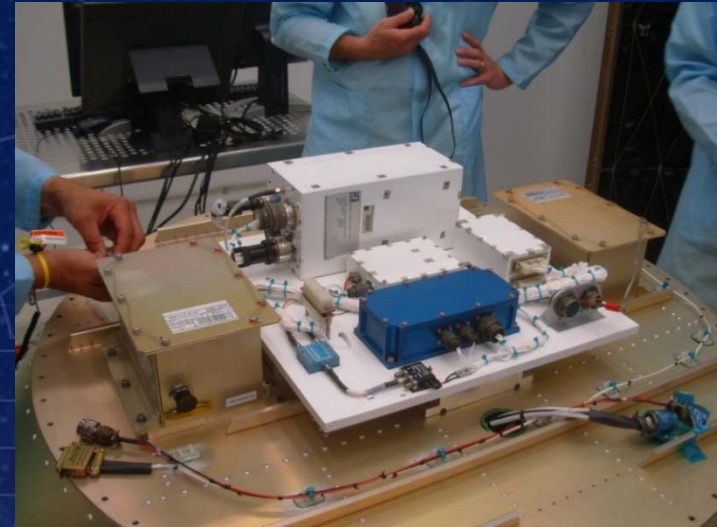
Autonomous Flight Safety System (AFSS)



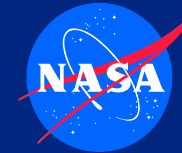
Autonomous Flight Safety System (AFSS) is an independent subsystem that uses tracking data from redundant GPS Receiver and IMU sensors to autonomously make flight termination decisions.

AFSS uses configurable rule-based software to decide whether or not to terminate the flight.

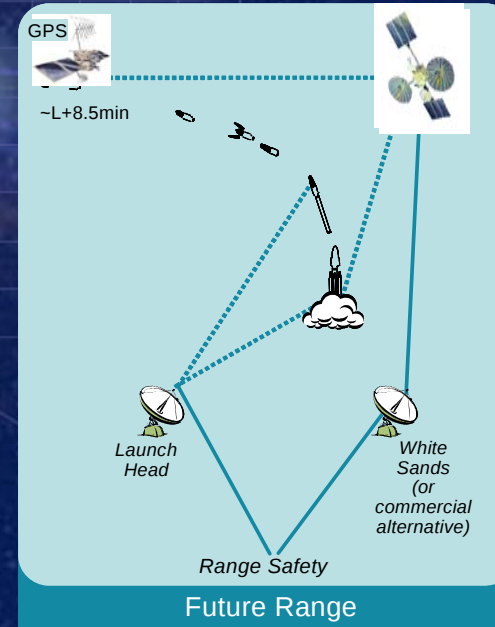
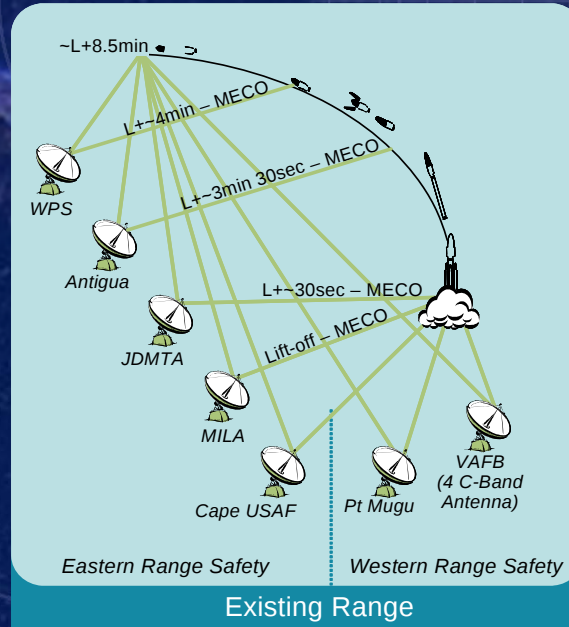
System has been successfully tested on a Sounding Rocket launched from White Sands and a SpaceX Falcon 1 ELV launched from Kwajalein Island.



Space-based Telemetry and Range Safety



- STARS reduces the need for ground based range assets to:
 - Increase Range responsiveness
 - Increase Range capacity
 - Reduce the cost of operations
- STARS uses state-of-the-art communications systems and components:
 - Uses existing proven satellite systems (TDRS and GPS) to provide reliable communications and minimize risk to the flight demonstrations.



SBIRIL_004v2

Communication Systems



High data rate and secure network communications; high definition television; emerging communications technologies, including: Ultra Wideband (UWB); Free Space Optics (FSO) and Extended Range Wireless Ethernet (WI-FI); radio frequency identification & tracking; oxygen-absorption secure wireless systems; field tests; published papers (laser beam wander, laser beam scintillation mitigation, plasma comm., Photonic Bandgap materials)



Photonic Band Gap Shield for Patch Antennas

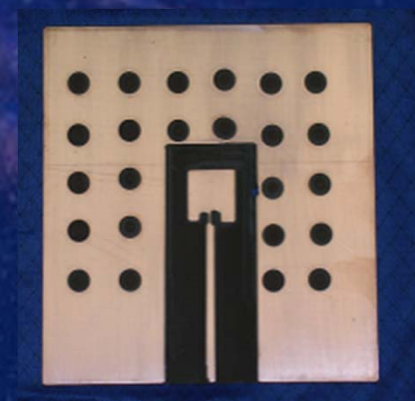
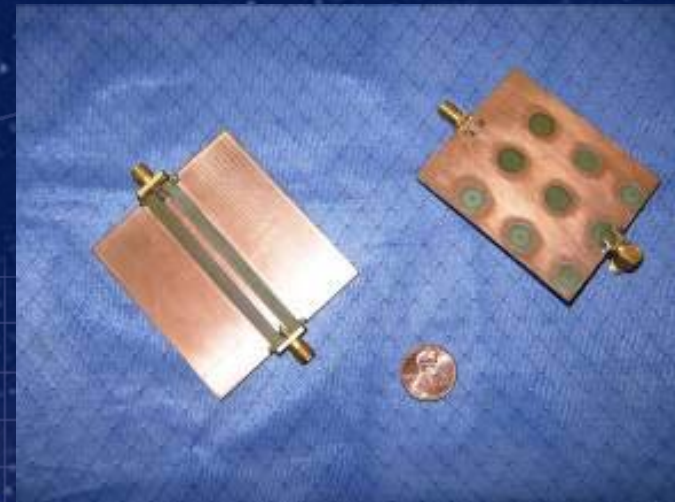


PBG technology provides light weight, thin, frequency-selective shielding materials and ground planes & suppresses circulating ground current losses effectively for RF & Digital Printed Wiring Boards.

Improves patch antenna efficiencies by nearly 3 dB.

Enables reducing antenna volumes without adversely affecting antenna bandwidth and efficiency.

Equivalent to achieving longer battery life for battery-powered equipment, or, equivalently, permitting using smaller & lighter batteries for the same operational life requirement.



Emerging Communication Technologies

Shuttle Landing Aids

Model-Based Diagnosis (MDB) Software

Non-Destructive Evaluation (NDE) techniques

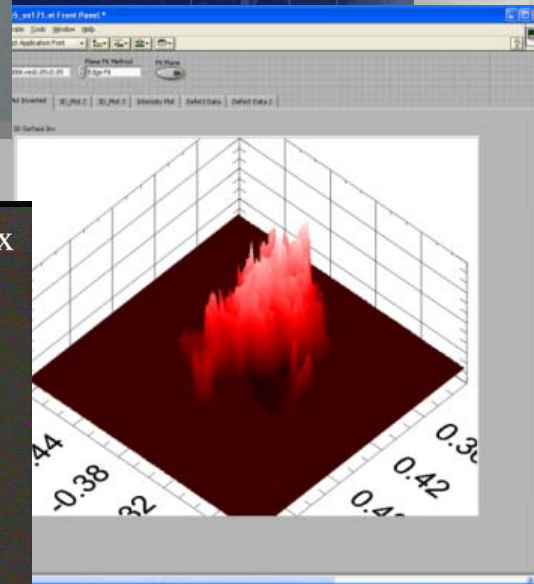
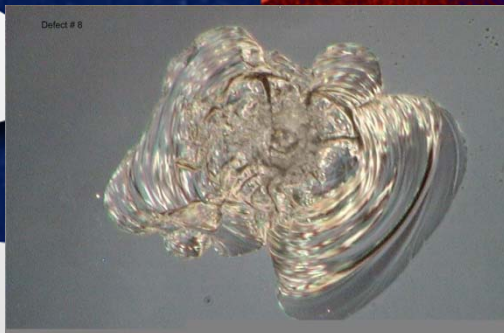
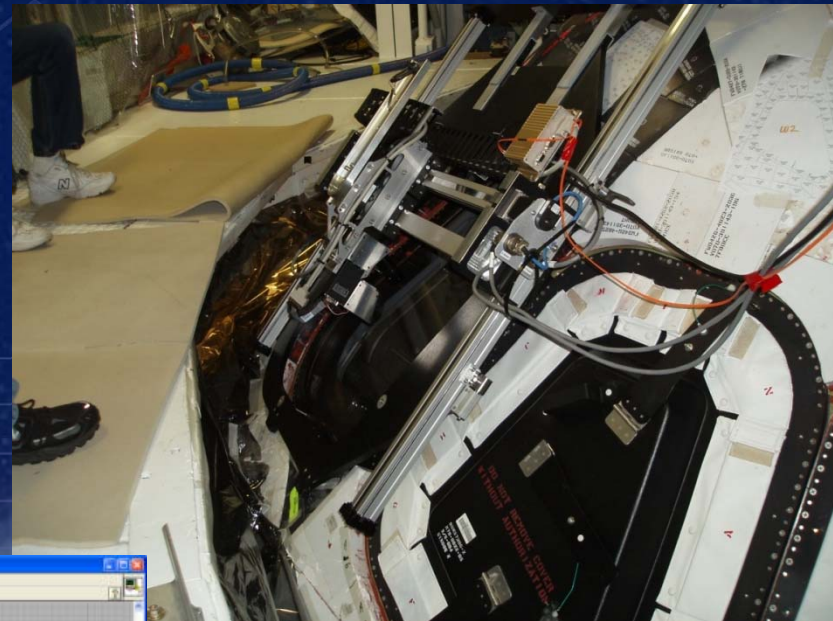
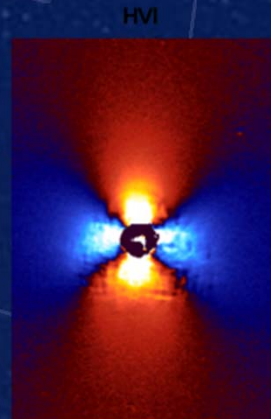
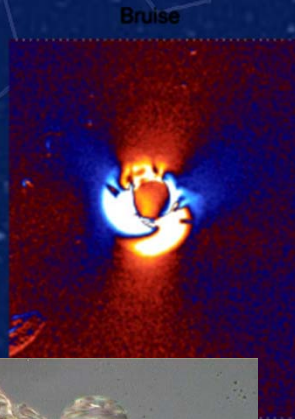
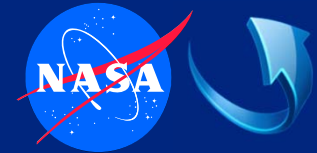
NDE Corrosion Under Paint

SOLLO Lightning detection

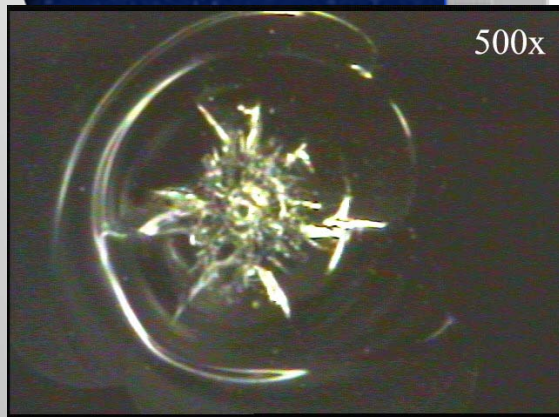
Space Based Telemetry and Range Safety (STARS)

Neural Network Pattern Recognition Systems

Non-Destructive Evaluation (NDE) Orbiter Window Inspection



**Orbiter Window Defect Detection
and Measurement**



0.00006" Repeatability

Non-Destructive Evaluation (NDE)



NDE technique development for customer applications

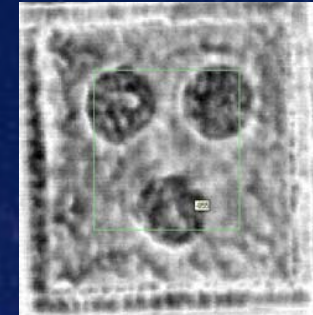
Millimeter Wave

Thermography

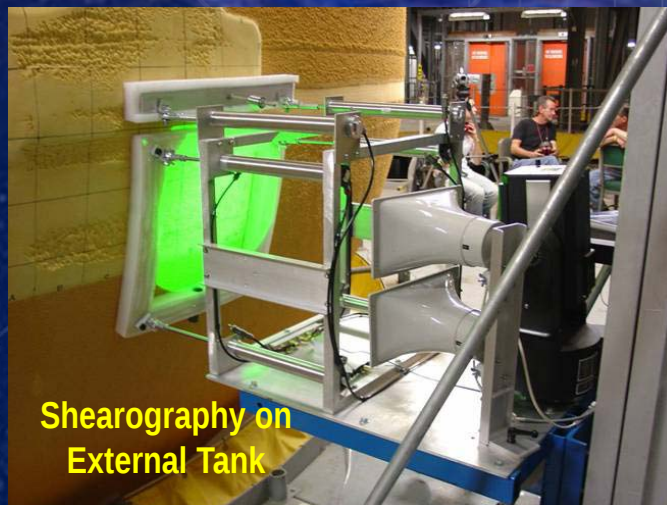
Terahertz

Shearography

X-Ray, Transmissive &
Backscatter



Corrosion Under Paint and Orbiter Tile



Shearography on
External Tank

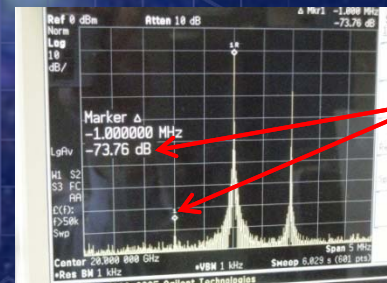
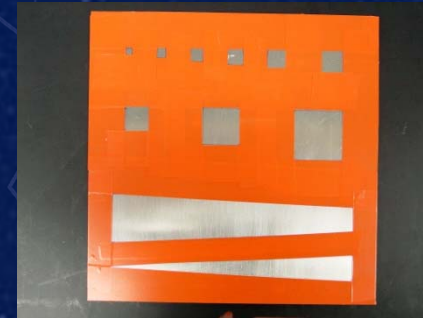


Backscatter X-Ray on PICA
Heat shield Material

Non-Destructive Evaluation (NDE) Corrosion Under Paint

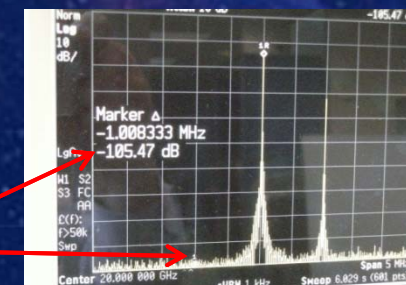


- Able to detect corrosion & pitting under paint for painted steel & painted aluminum materials – TRL 4
- Can Image corrosion under 14 inches of coating / insulation
- Technique is suitable for inspection of structures (bridges, ships, etc.), insulated steel pipelines (oil industry), and insulated cryogenic pipes.

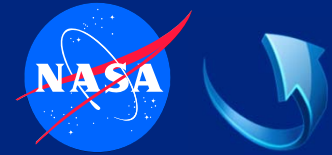


Detecting
Corrosion

Indicating No
Corrosion



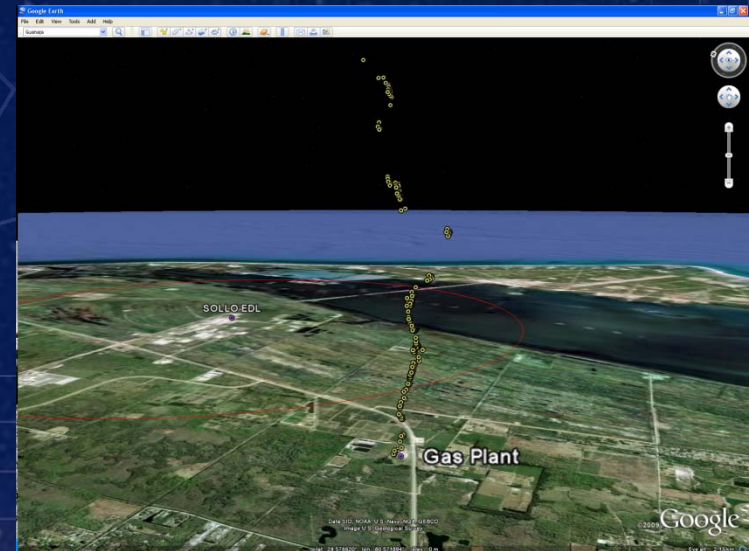
Lightning Detection & Analysis



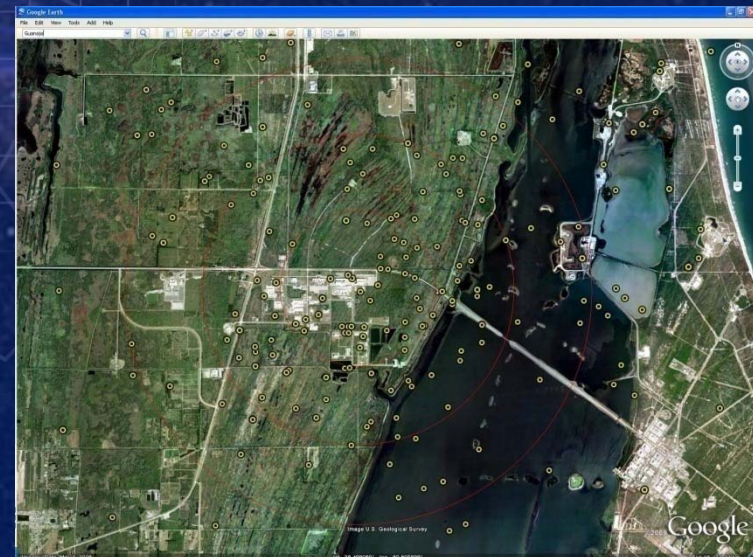
The Sonic Lightning Location (SOLLO) system utilizes an array of four microphones and an RF antenna to identify the location of lightning channels in three dimensions.

A series of thunder claps and EM pulses were recorded over the summer of 2009 in an effort to quantify the accuracy of this system in locating lightning strikes.

A system has been deployed at M7-409, SLC-17, and near the Camp Blanding triggered strike facility in Starke FL.

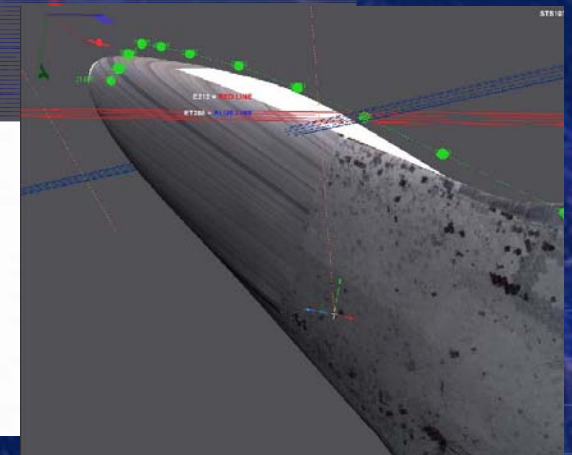
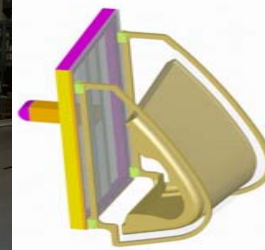
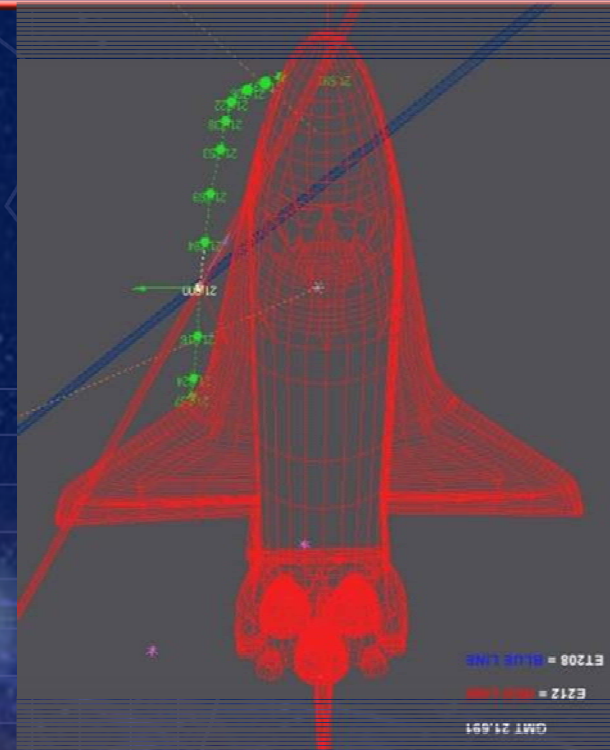
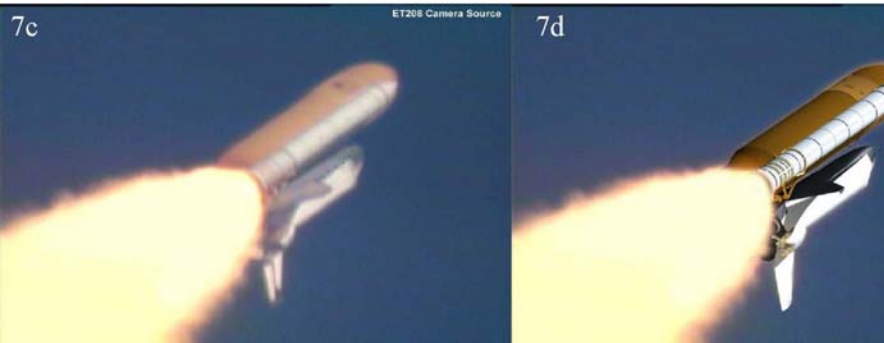
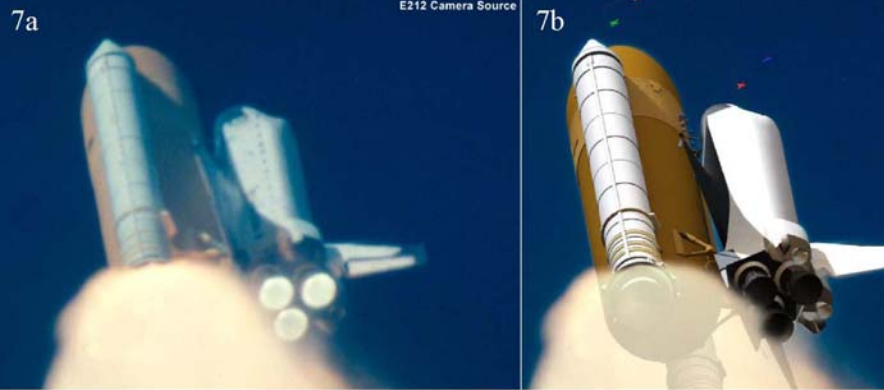


Air Liquide plant outside KSC Gate No. 3 four miles away from SOLLO

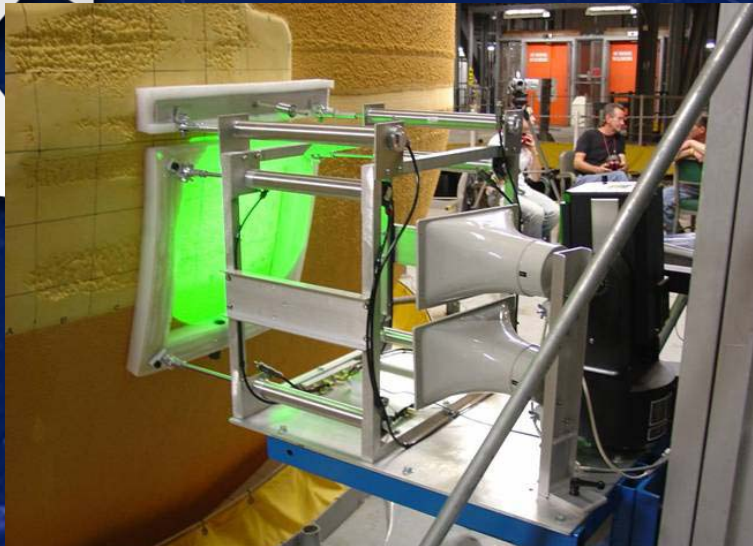


SOLLO strike locations for the KSC Industrial Area, 2009.

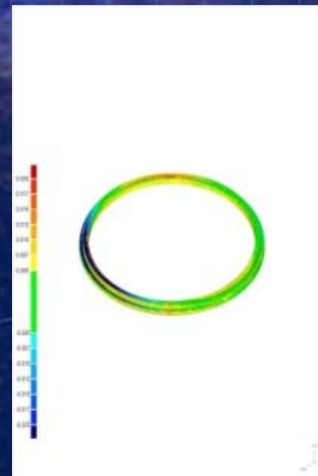
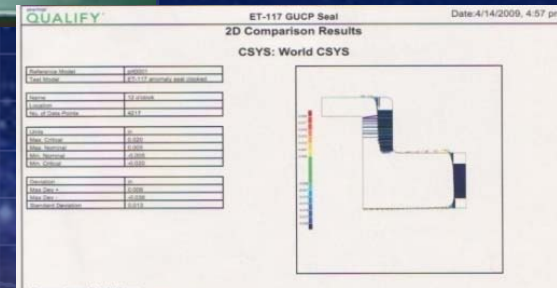
Columbia Accident Investigation



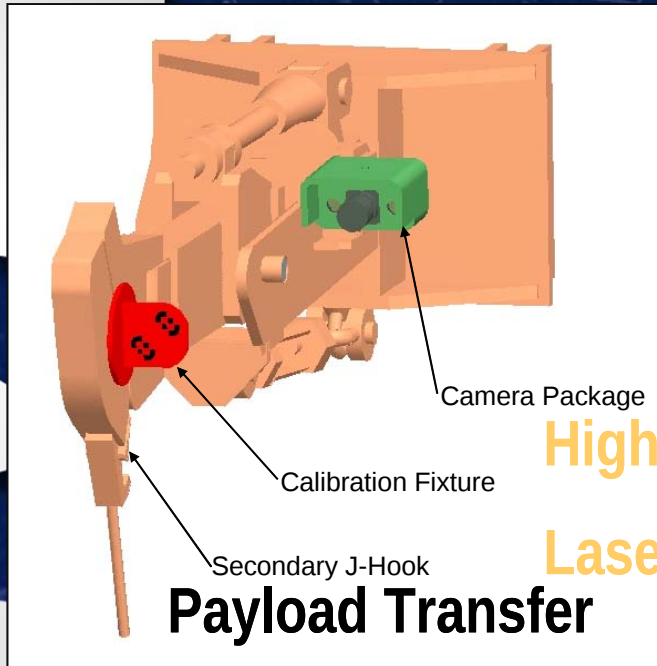
Return to Flight



Launch Anomaly Investigation Teams

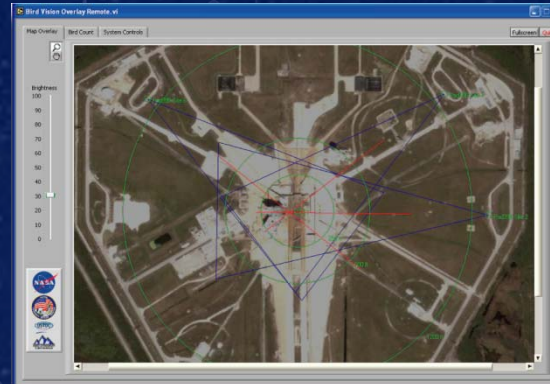


Capability: Image Analysis

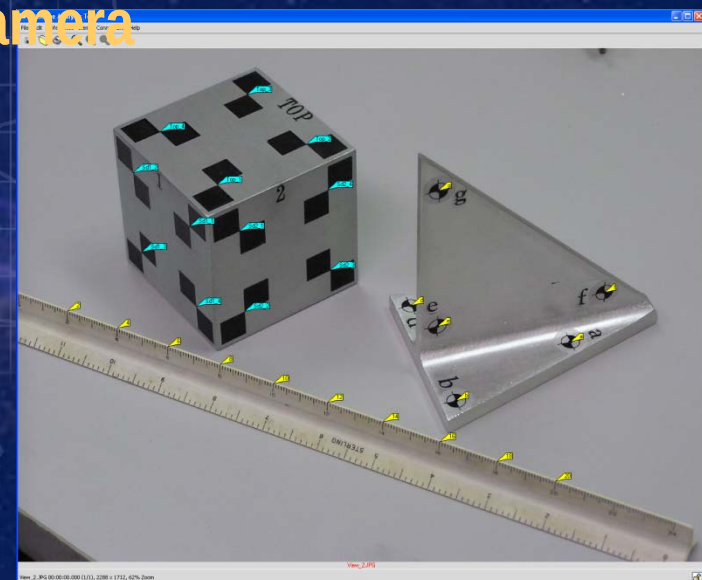


High speed video camera

Laser measurement

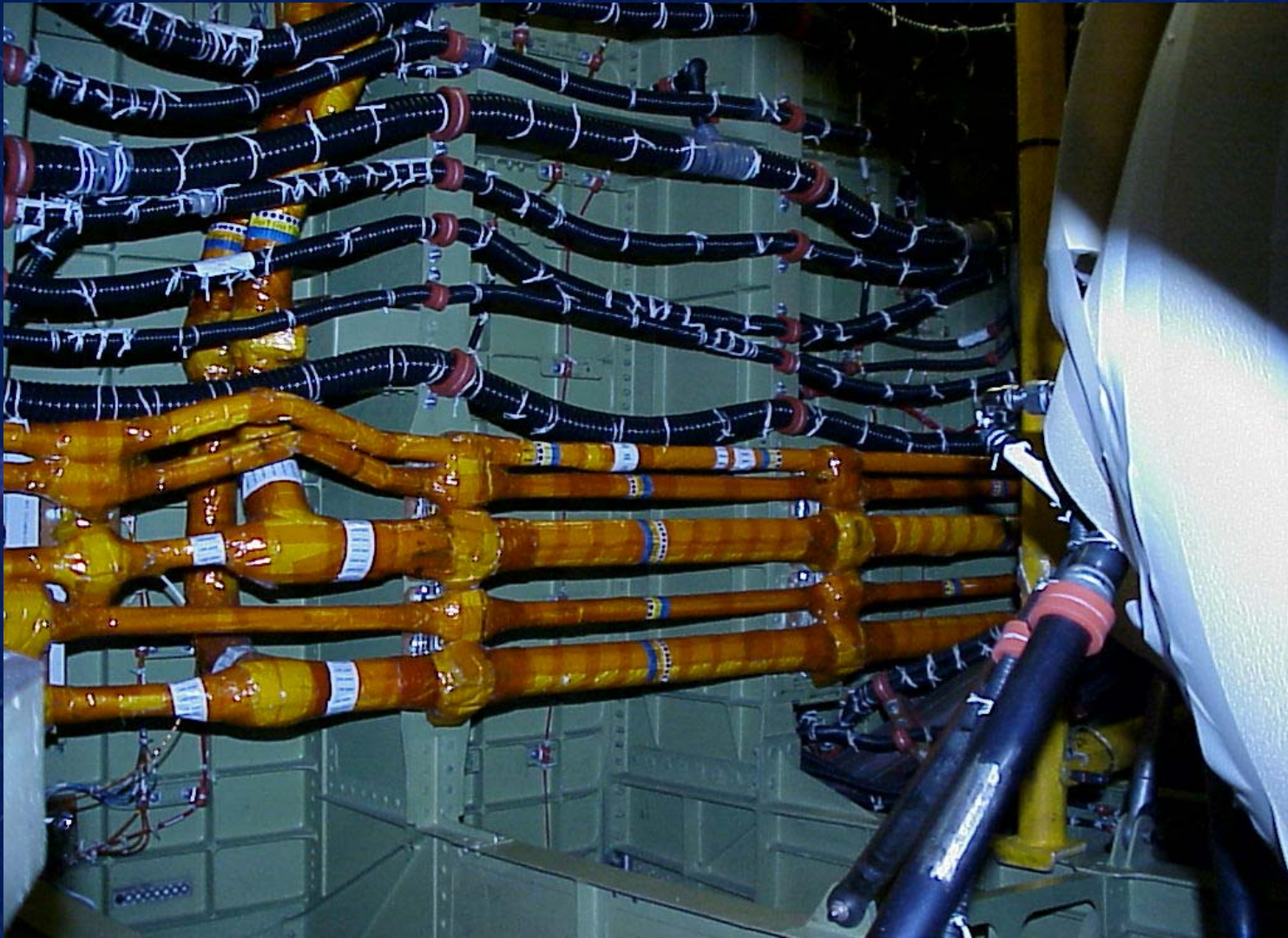


Flame Trench - High Flyer

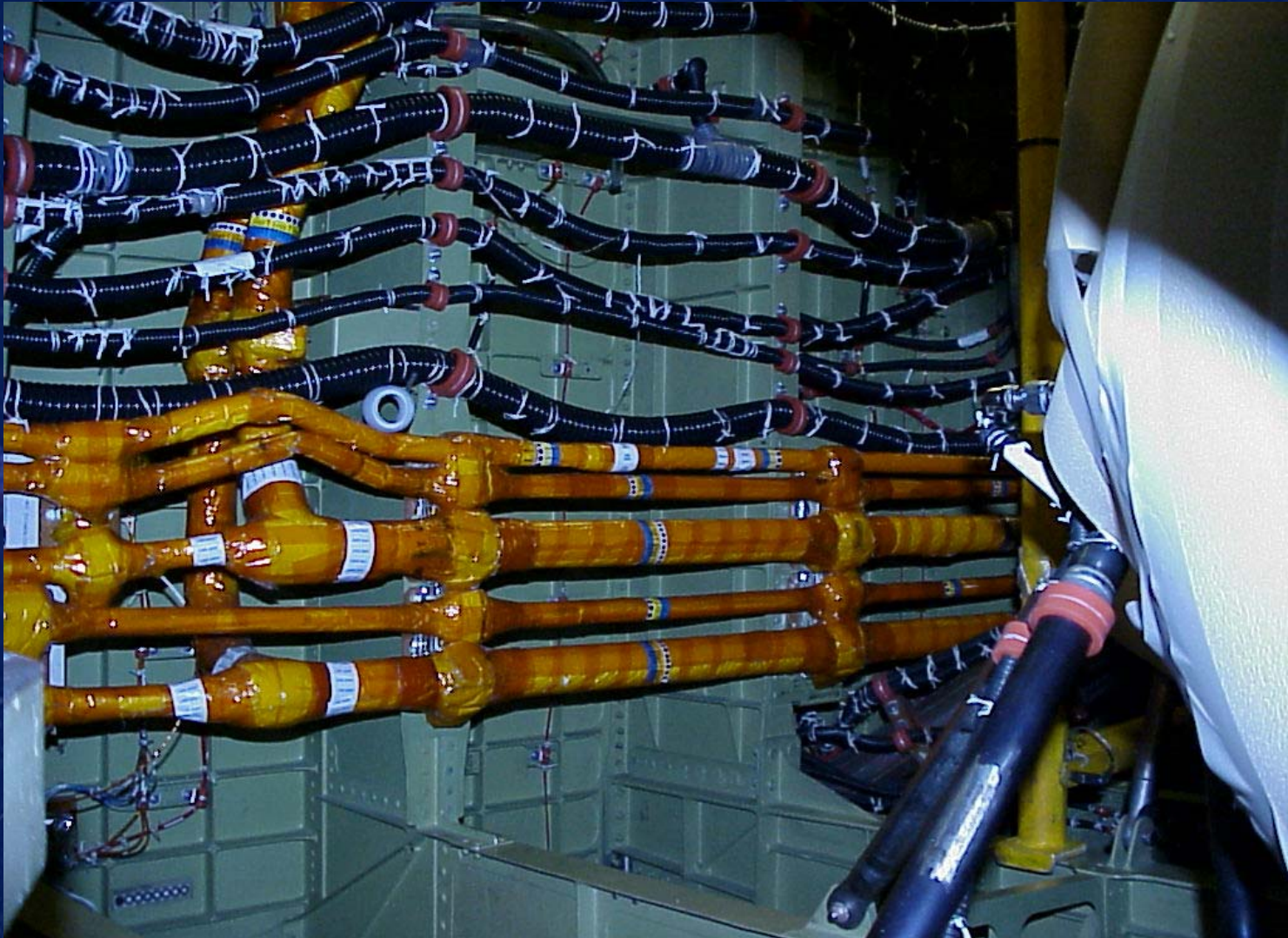


3-D Crime Scene Analysis

Capabilities: Software Image Subtraction



Capabilities: Software Image Subtraction



Capabilities: Software Image Subtraction



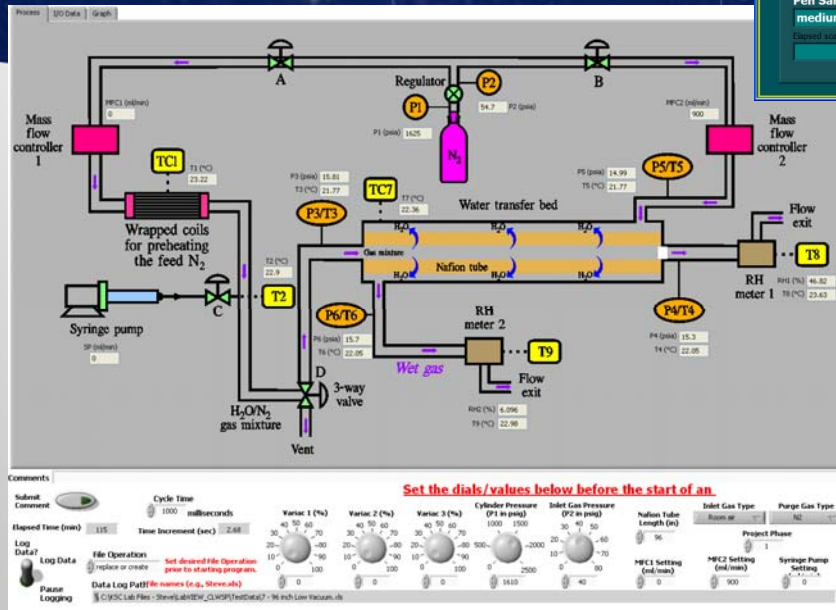
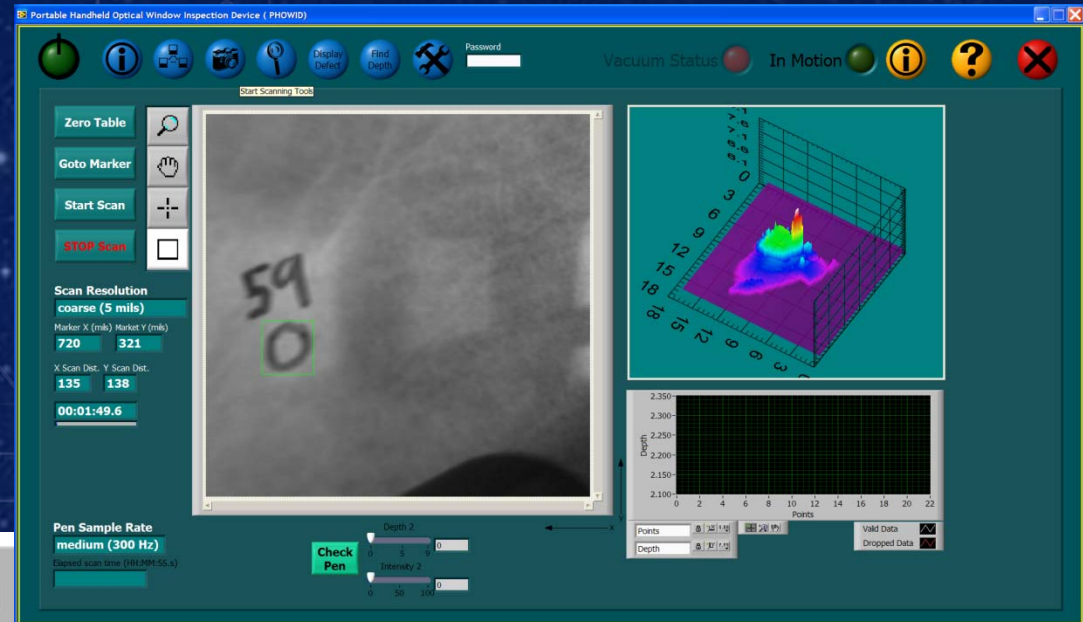
Clear
Tygon
Tube

0.05"
Tether
String

Tether
String
Shadow

Roll of
Tape

Capability: Software GUI



Develop computer interfaces to monitor and control chemical processes

Programs are written in LabView (CompactDAQ and CompactRIO NI hardware systems)

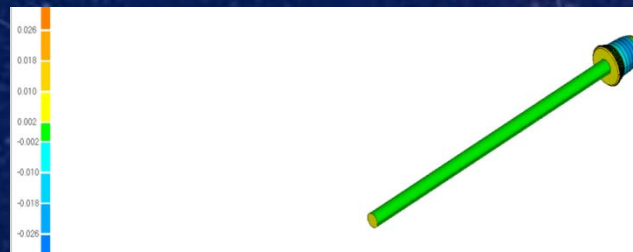
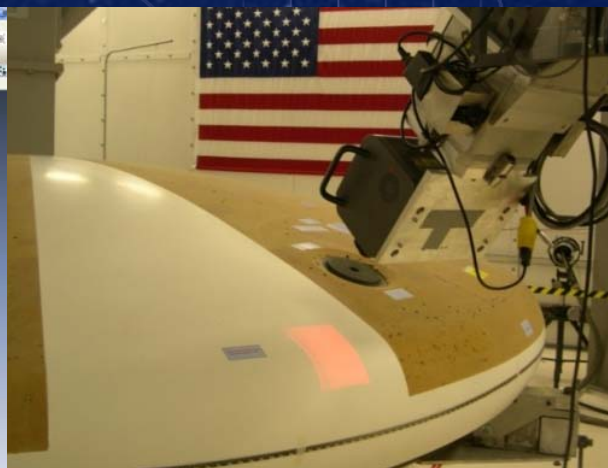
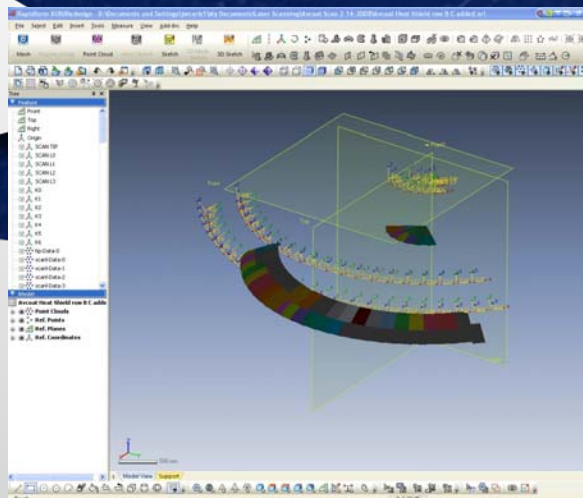
Written software for fundamental first generation laboratory experiments to full-scale integrated field tests

Capability: Complete Design Development



Reverse Engineering:

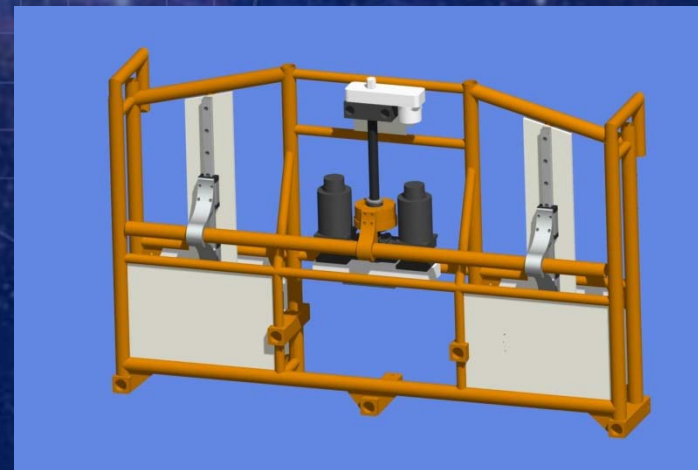
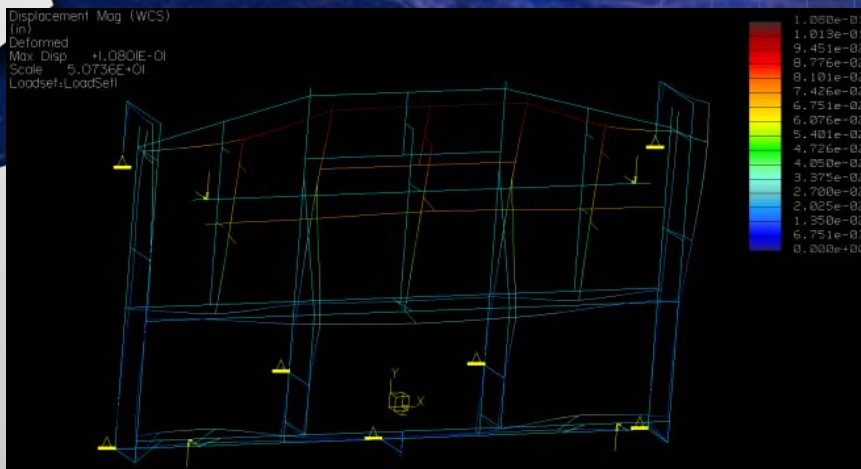
- Laser Scanning
- FARO Arm



Capability: Complete Design Development



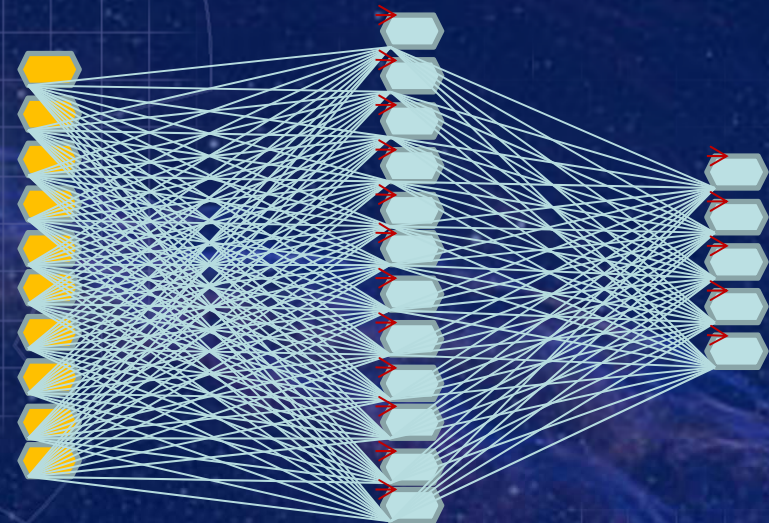
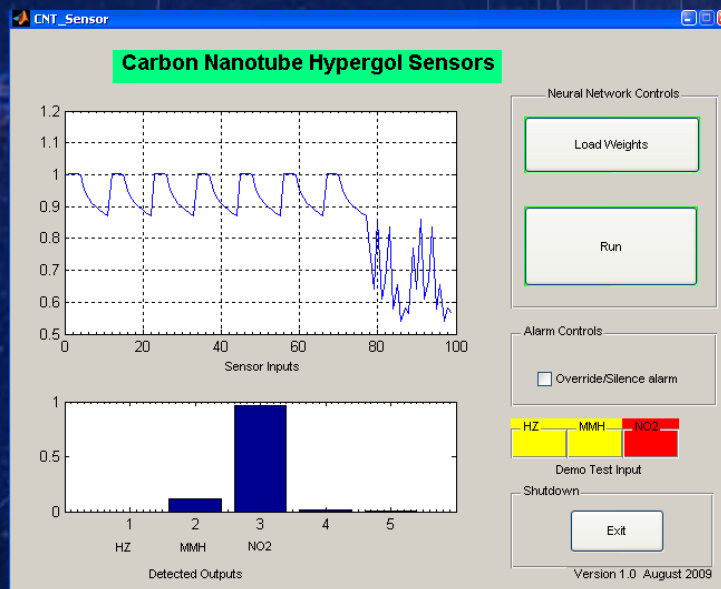
- CAD, CAM & CAE
- Rapid Prototyping



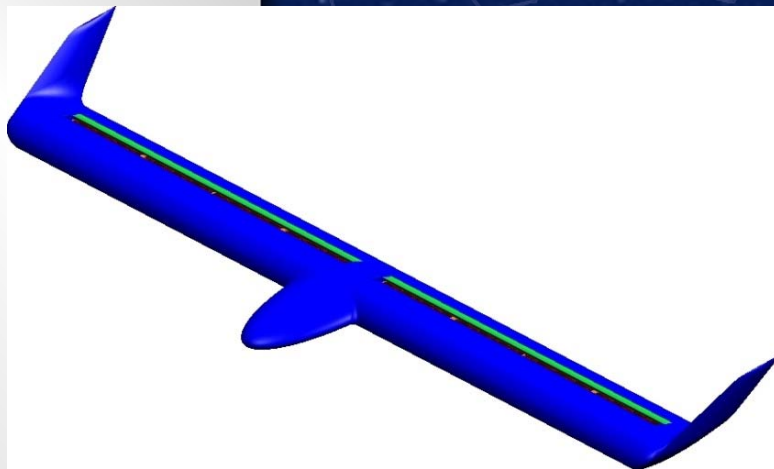
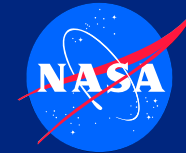
Technology Advancement: : Neural Network Pattern Recognition



- Hazardous Gas Detection Systems
- Corrosion Under Paint (CUP) Detection Systems
- Liquid Oxygen (LOX) Pump Imminent Failure Prediction Systems

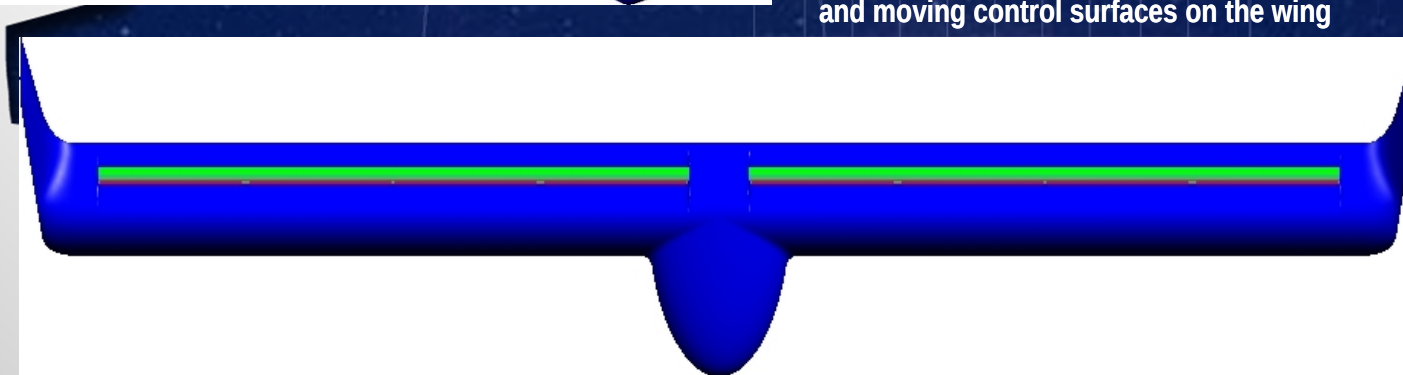


Technology Advancement: Composite Fuel Cell Powered Aircraft



- All-electric aircraft
- Powered by a PEM fuel cell
- Hydrogen fuel is stored at cryogenic temperature
- Exhaust is water vapor
- Thrust is generated by internal crossflow fans
- Control is maintained by varying thrust and moving control surfaces on the wing

Takeoff Gross Weight	2,000 lb
Payload Weight	200 lb
Wing Area	480 ft ²
Maximum Wing Loading	4.2 lb/ft ²
Loiter Altitude	60,000 ft
Loiter Airspeed	120 knots
Maximum Endurance	> 4 days



Technology Advancement : Modular Rapid Cryo Propellant Loading Test System



Advanced software for fault detection and response, Ruggedized Temperature and Pressure Xmitters, Smart Sensor Technology, Composite Cryogenic Tank, Parallel Pumping of cryos

Pump outlet flow optimization (Parallel Pumping), Magnetic coupled pump, Development of new LOX Pump Oil, Development of new thrust bearing technology.

System can be used to test and validate cryogenic components, instrumentation, software and systems.



Pump and Control Skids



Skid View Looking East

Innovative Partnerships

- Partnership Development Experts for Technology Research, Development, Marketing and Transfer
- Assess new technologies and innovations for commercial potential.
- Infuse new technologies from industry into NASA mission.
- Recommend Intellectual Property path for technology.
- Package and Market technology to industry and government agencies.
- Coordinate Partnerships with NASA for technology research and development.
- Coordinate Innovative Partnership Program Royalty and Seed Fund programs including providing proposal guidance.
- Support NASA's Small Business Innovation Research program.

USTDC Strengths



Standing force of world-class, highly-trained, experienced engineers, scientists, researchers, analysts, technicians, and engineering support staff members

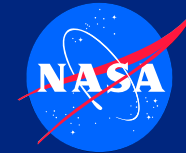
A proven track record for developing and delivering innovative solutions quickly within the environment of a national resource to solve the most-technically challenging problems, both within KSC and among Industry, necessary to keep NASA flying and the United States world-competitive

Superior record of technical, management, schedule, & cost performance within very difficult technical constraints

Quick response engineering capability

Cost/Value Added service

Current Technology Evolution



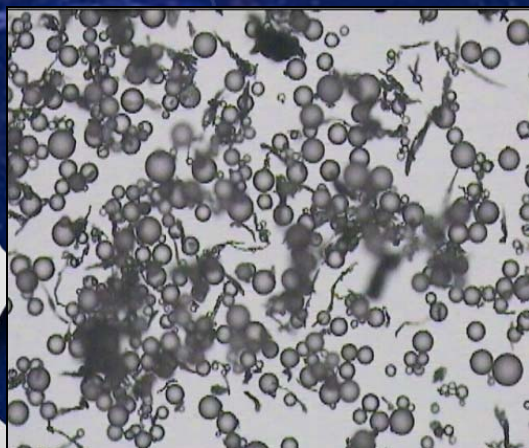
Applied Chemistry Laboratory

*O&C and SLSL Buildings
Kennedy Space Center*



Expertise

Expert skills in polymer chemistry, analytical chemistry, physical chemistry, advanced materials, fluorescence, organic synthesis, laser spectroscopy, electrochemistry, analytical instrument development/testing, fabrication, machining, mathematical modeling, and software development. Technology development in toxic vapor detection, chemical scrubbers for toxic waste, microencapsulation of materials for space applications, hypergolic fuel dosimetry, hydrogen detection, self-healing wire insulation, minimally intrusive repair methods for electrical wiring, and environmental remediation



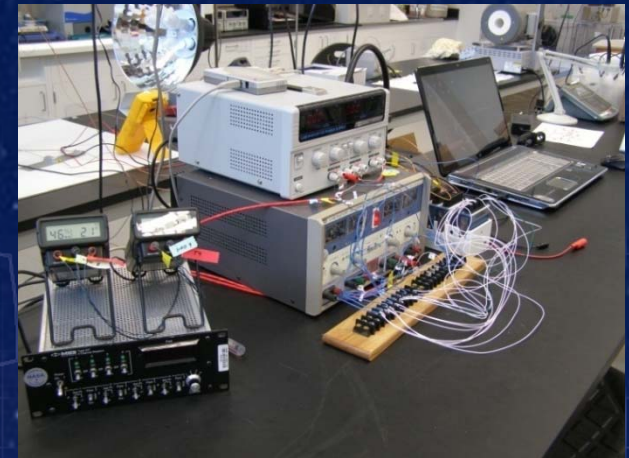
Membrane Water Separation



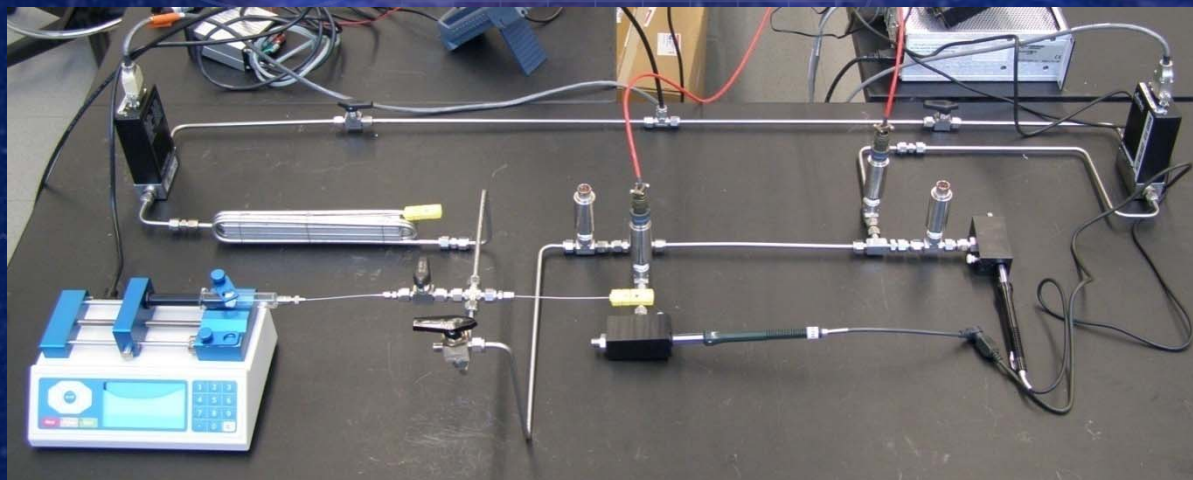
Designed, built, and tested a new method to continuously separate, capture, and quantify water from a mixed gas stream

Advantages over existing technology:

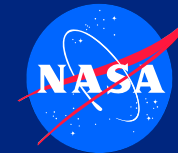
- Continuous process
- No high temperature desorption step required
- Energy efficient
- Highly selective for water separation
- Low maintenance/no moving mech. parts
- Extreme membrane stability



Goal: Develop the technology to be useful for all ISRU applications



Lunar Oxygen Production by



Electrolysis

Molten Regolith Electrolysis is a one-step process to separate oxygen from oxides that make up the lunar soil. Kennedy Space Center works with MIT, FIT, and Ohio State U. to develop the technology for a lunar outpost.

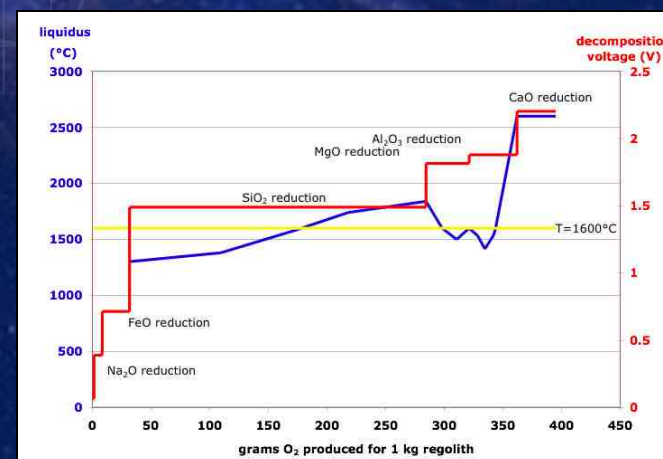
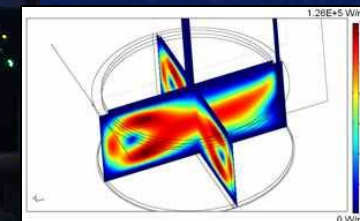
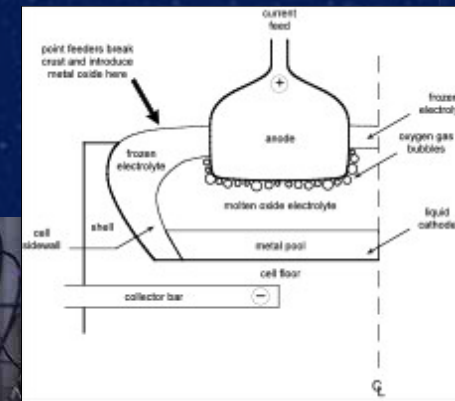
The process is similar to that used in industrial aluminum production. Major differences:

Temperature is 1600° C instead of 900° C.

No chemical agents are added to dissolve the soil in its own melt (aluminum oxide is dissolved up to 3% by volume in fluoride salts)

Inert anode is used to form oxygen instead of carbon electrodes that produce CO₂ in aluminum production.

The potential imposed and the temperature dictate what metals can be reduced: iron and silicon alloy in liquid state at the bottom.



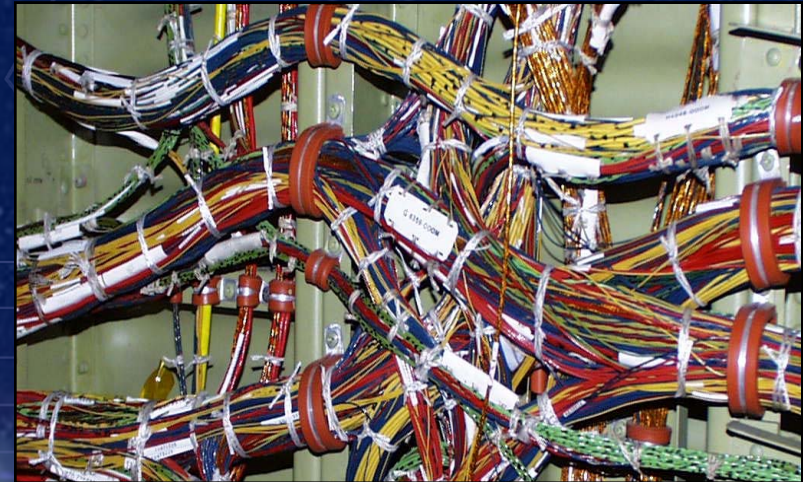
Manual Wire Insulation Repair



**Minimally intrusive manual repair
for polyimide and fluoropolymer
wire insulation**

**Samples evaluated for chemical,
mechanical, and electrical stability**

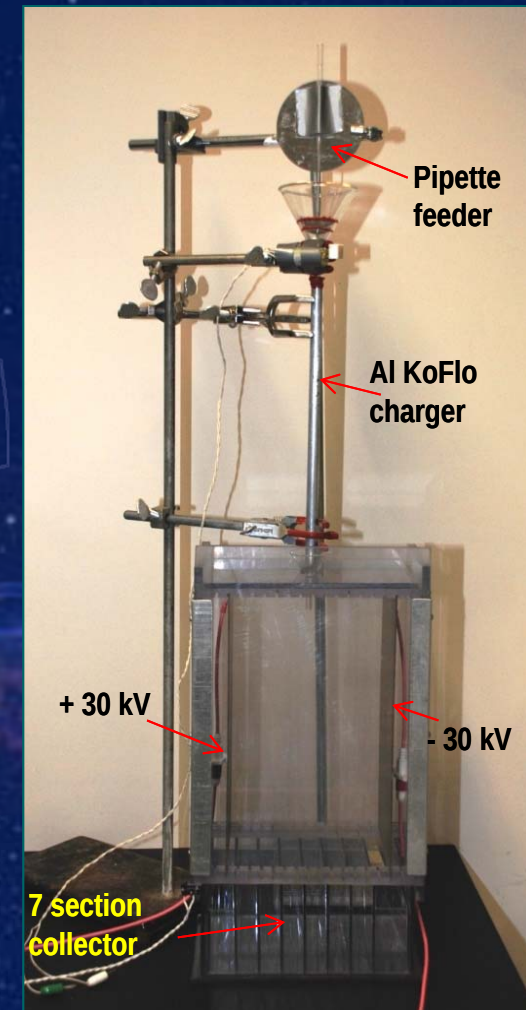
**Proof-of-concept repair kits being
developed and will be evaluated by
the Naval Air Command (NAVAIR)**



Achievements:

- Use of strong electric field to separate mineral components of lunar regolith
- Separated dust collected in a series of bins arranged between the plates.
- For JSC-1A separation of the metal oxides was not achieved.
- For KSC-1 (38% Feldspar, 38% Spodumene, 15% Olivine, and 9% Ilmenite) - significant separation was achieved.
- USGS NU-LHT-2M showed favorable results with new optimized parameters.
- Successful separation of Apollo 14 lunar regolith.
- Beneficiation of Lunar Simulant to be published in NASA Tech Briefs.
- New beneficiator design successfully flown on reduced gravity flight at 1/6G.

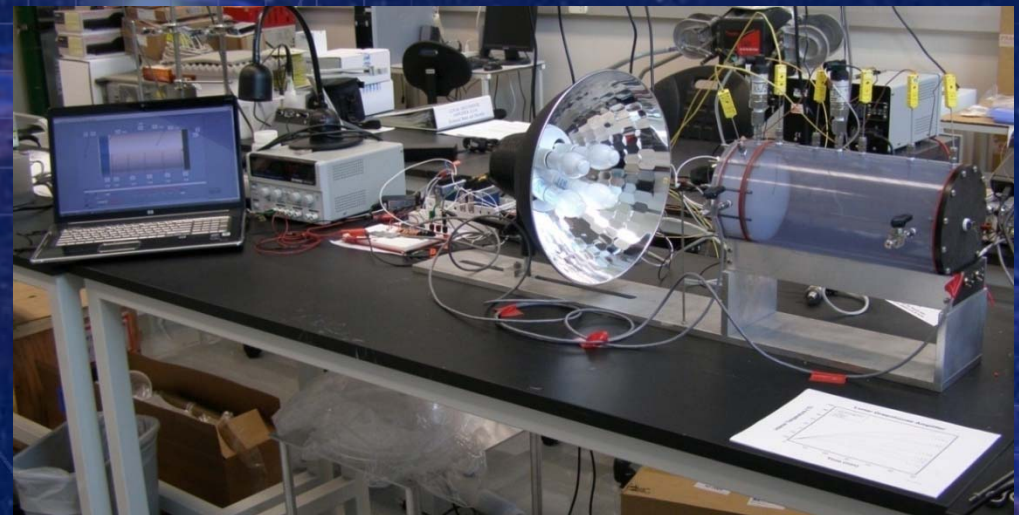
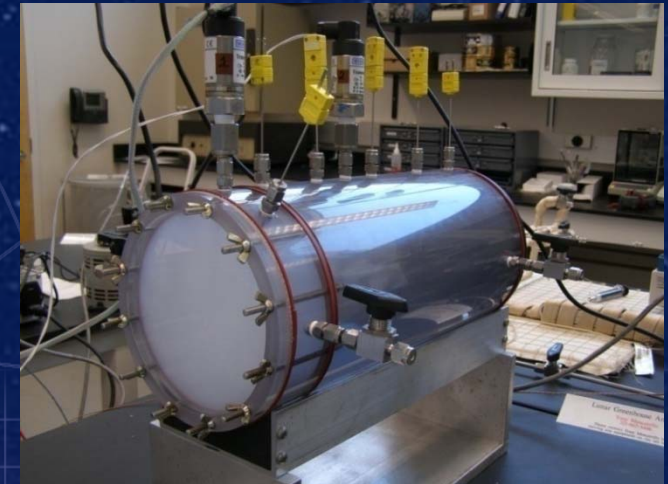
Showing that a simulant can respond electrostatically will help in the design buildup and testing of regolith mineral separators when a habitat is established on the moon. The efficiency of reduction based regolith oxygen generators will see the greatest benefit from this technology.



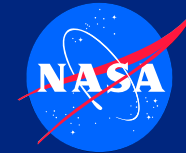
Prototype greenhouse uses super greenhouse gases

Plastics must be used for lunar greenhouses instead of glass; plastics lose heat readily

The use of insulating gases overcome the heat loss by absorbing the reradiated IR and containing it within the chamber.



Hypergolic Indicating Wipes



Develop a modified indicator wipe to detect hypergols when exposed to salt-water environments. Previous work developed wipes that detected hypergols in an aqueous solution.

Concerns during field testing with the non-volatile (NVR) residue from the wipe substrate itself. Using wipe material certified by USA for use on flight hardware (minimal NVR).

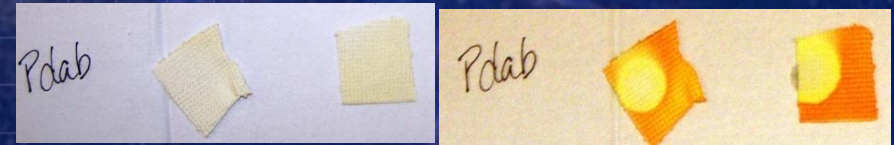
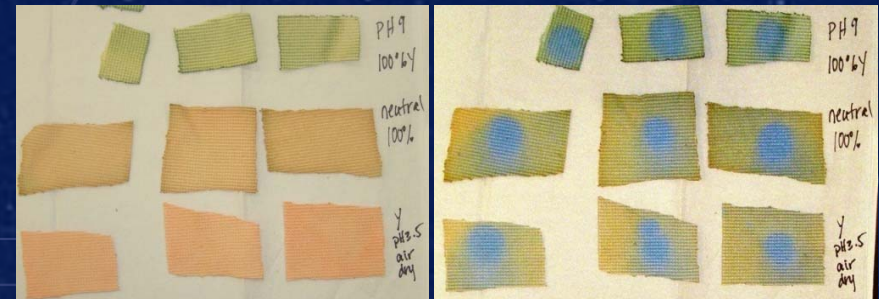
Yamada Universal Indicator (pH range: 3-11) along with several other commercially available indicator solutions have been tested (indicator strengths and solution pH values have been varied).

A gold salt used to detect the presence of hypergol vapors has shown promise. This material has been previously developed by WSTF for indicating the presence of hypergol vapors.

PDAB and vanillin are undergoing evaluation as complexing agents. They are currently used in the hypergol fuel dosimeter badge.

Before

After



Indicating wipes before and after hydrazine fuel exposure

Yamada (pH 9/7/3) – TOP

Gold Salt - MIDDLE

PDAB - BOTTOM

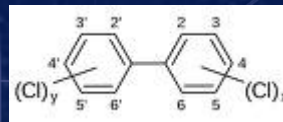
Bimetallic Treatment System (BTS)



Goal is to produce a cost-effective in-situ treatment system for removal/degradation of polychlorinated biphenyls (PCBs) from paints, caulking, and other coating materials

Current technology requires the destruction of the contaminated materials, BTS would render the previously contaminated materials non-hazardous

BTS employs elemental magnesium coated with a small amount of palladium in a solvent capable of hydrogen donation



BTS is designed to remove the PCBs by opening the polymeric lattice of the paint, not destroying it. Also, the formulation used can be customized via laboratory testing for specific contaminated sites/materials to increase effectiveness

Several field demonstrations have been performed at various sites, including Marshall Space Flight Center, Badger Army Munitions Depot, and the Verticle Integration Building (VIB) at Kennedy Space Center

Results have demonstrated the effectiveness of BTS as a PCB remediation tool

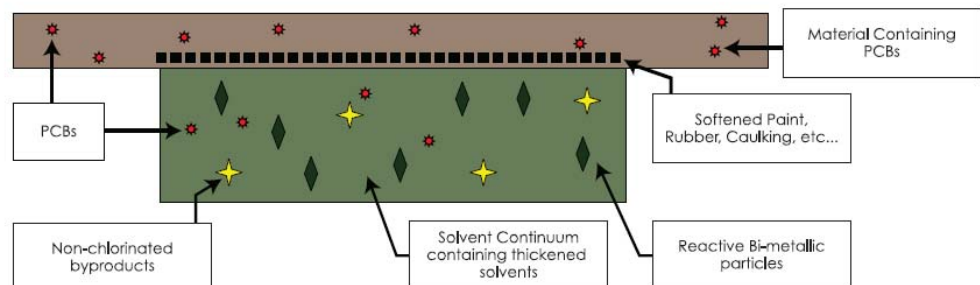
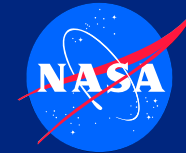


Figure 1: Schematic of BTS

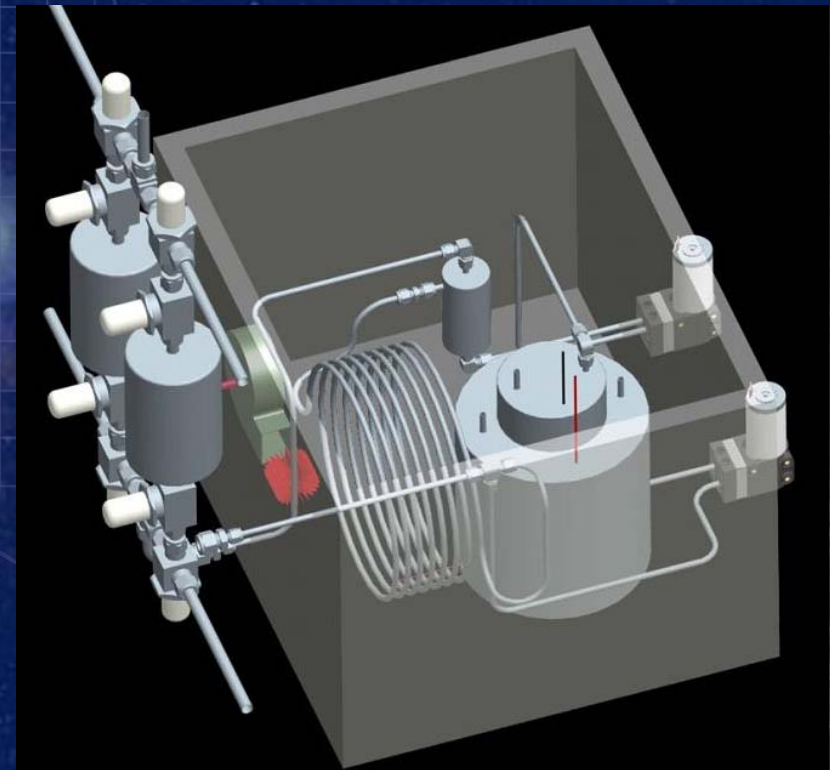
Contaminant Removal from Oxygen Productions Systems



Hydrogen reduction systems produce water by reacting hydrogen with oxides in lunar simulant. A number of corrosive acid gases are produced as byproducts which can damage system components.

Combination of ionic liquids and solid catalysts used to remove the different acid gases.

System is being designed to be regenerable – materials used are not consumed during the contaminant removal process. This zero-maintenance design is ideal for lunar outpost scenario.



Laboratory Equipment

- GC/MS, electron ionization (EI) or positive/negative chemical ionization (CI) KIN-TEK vapor standards generators (dynamic range for hypergols: 10 ppb to 500 ppm)
- Dionex Ion Chromatography System (auto sampler with electrochemistry detector)
- Tenney Versa Tenn II Environmental Test Chamber
- BAS 100B Potentiostat, BAS Galvanostat (LG50), and PWR3 Power Module
- Agilent 5973 Gas Chromatograph with Mass Spectrometer (GC/MS)
- Agilent 7970 GC with flame and thermal conductivity detectors with gas-sampling and column switching valves
- Varian Triple Quadrupole
- Shimadzu 8400S Fourier Transform Infrared (ATR, Diffuse Reflectance)
- Varian high-performance liquid chromatography (HPLC), ultraviolet (UV) detector, refractive index detector, gel permeation column
- Thermo Fisher Ion Trap Mass Spectrometer
- Jasco V-670 UV-Vis-NIR Spectrophotometer
- Konica Minolta ChromaMeter 400 (color analysis)
- Ocean Optics Fiber Optic Fluorometer
- Spex FluoroMax-3 Fluorometer
- Instrument Specialists Simultaneous Differential Scanning Calorimeter (DSC)/Thermo Gravimetric Analyzer (TGA)
- LECO TCH600 Nitrogen/Oxygen/Hydrogen Determination
- Instron 3344 Universal Testing Machine
- TA Instruments Q50 TGA
- TA Instruments Q200 DSC
- TA Instruments Q800 DMA
- Labconco FreeZone 4.5 Freeze Dryer System
- ATM Sonic Sifter
- Two PowerGen homogenizers
- Various high-speed mixers

Laboratory Services

Generation of hypergolic vapors from 10 parts per billion (ppb) to several
Analytical services, including gas chromatography/mass spectrometry (GC/MS), ion chromatography (IC), ultraviolet-visible spectroscopy (UV-Vis), Fourier transform infrared spectroscopy (FTIR), high- performance liquid chromatography (HPLC), fluorescence spectroscopy, differential scanning calorimetry (DSC), thermo gravimetric analysis (TGA), and Instron tensile and compression testing.

Electrochemistry: direct current/alternating current
electrochemical experimentation and analysis

Coulometric analysis of vapor samples

Environmental test development and evaluation



Polyimide Powder Coatings
Hydrazine Detection Via Derivitization
Halon 1301 Replacement Materials
Hydrogen Detecting Tape Technology
Environmental Remediation
Nitrogen Tetroxide Scrubber Technology
Membrane Technology
Ionic Liquid Technologies
Hydrazine Scrubber Technologies
Methane Production from Plastics
Lunar Materials Processing
Hypergolic Wipes
Polymer Coatings for Metals and Microcapsules



Electrostatics and Surface Physics Laboratory

*SLSL Building
Kennedy Space Center*

Facilities/Capabilities

Vacuum Systems

Three Environmental Chambers

Field Emission Secondary Electron Microscope

Atmospheric Plasma Glow Discharge Sources

Electrostatics Measuring Equipment

X-ray Photoelectron Spectroscopy

Atomic Force Microscopy

UV Source and Monochromator

Contact Angle Measurement

Optical Emission Spectrometer

Lunar and Mars Simulants

Sputter Coater



XPS Lab



Dust Mitigation on Fabrics using

CNT Inks

Flexible, polyurethane-based screen coating in use

Single-phase electrodynamic screens printed onto Nomex fabrics using single wall carbon nanotube doped inks

Printing single-phase electrodynamic screens directly onto polyurethane substrate to allow for use on any fabric

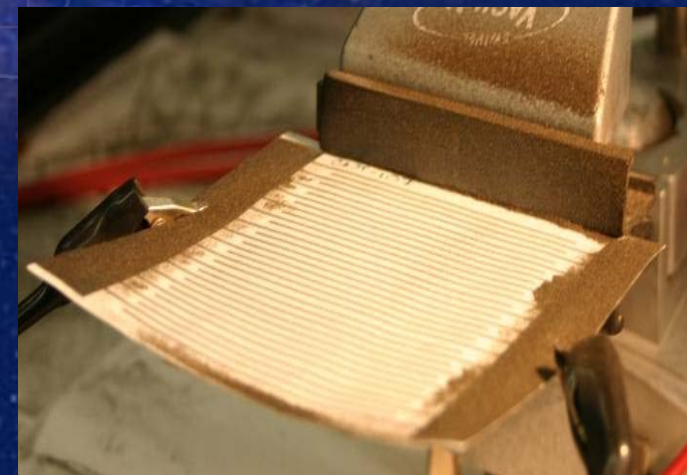
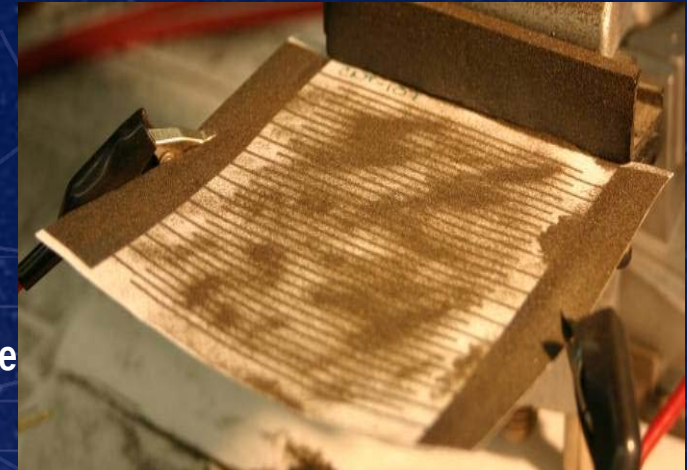
On-going research:

- Optimization of ink and screen patterns

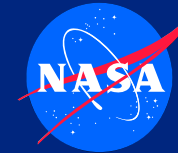
- Development of printing methods on Nomex fabrics

- Double-wall CNT ink on Nomex fabrics

- Use of screens on Ortho fabric



Triboelectric Effects on Mars



Viking Landers discovered a complete lack of organics on the surface of Mars

The leading theory to explain the lack of organics in the Martian soil is chemical breakdown caused by incident UV irradiation.

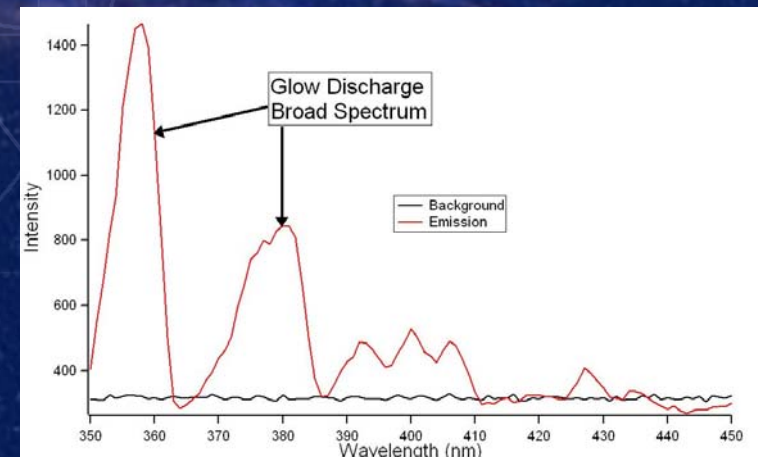
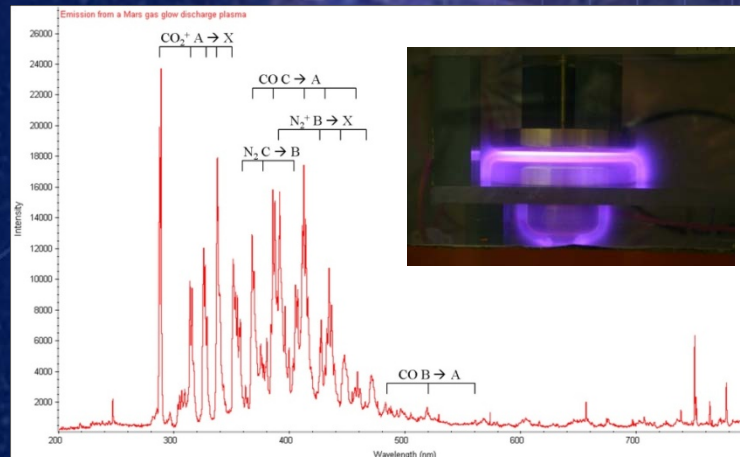
The ESPL is testing another hypothesis based on the ever-present triboelectric charging of particles immersed in dust devils and planet-wide dust storms.

Triboelectric charging of dust results in a Glow Discharge Plasma under Martian pressures.

Plasmas are known to create high energy UV radiation, energetic ions, free radicals and chemically reactive neutral species. Plasmas are typically used to sterilize instruments in hospitals and breakdown organic molecules.

We have measured the spectrum from an artificial GD plasma and are in the process of resolving the spectrum from a triboelectrically-induced Mars GD plasma which has never been observed before. The plasma is generated by simply shaking JSC-1 Mars simulant soil under Martian conditions

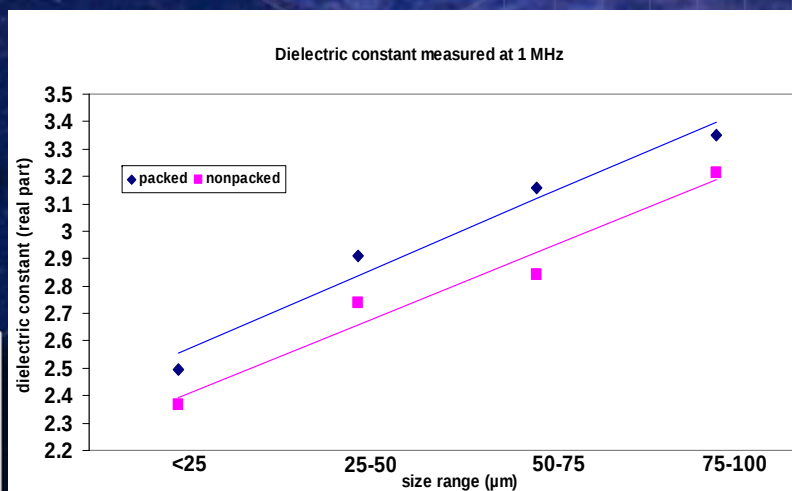
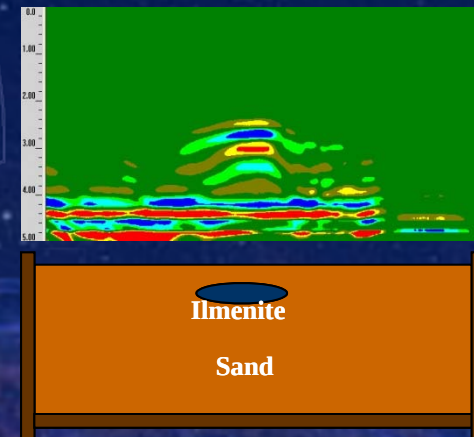
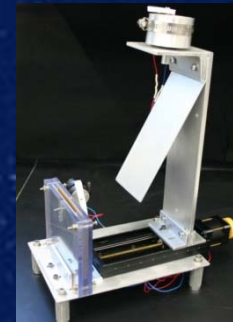
Ultimately we would like to compare the organic degradation rates of solar UV chemical breakdown compared with triboelectric chemical breakdown.



Characterization of Lunar Minerals



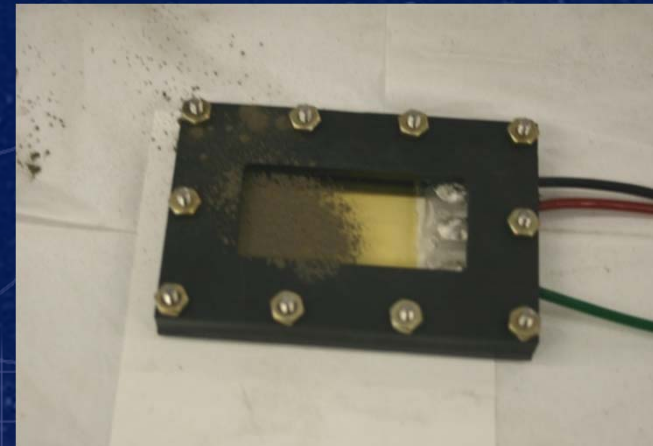
- The priorities for demonstrating lunar ISRU capabilities emphasize the need for excavation and transport of lunar regolith for water, oxygen, energy production, and for structural and shielding fabrication.
- In order to test the capabilities - need for accurate models of the natural resources. Ilmenite (FeTiO_3) is considered a prime candidate as a lunar oxygen source.
- Ground Penetrating Radar proposed as method to detect sub-surface ilmenite. GPR detection is function of dielectric constant differences.
- Measured dielectric constants of JSC-1A, ilmenite, spodumene, olivine, feldspar and Apollo 14 regolith.



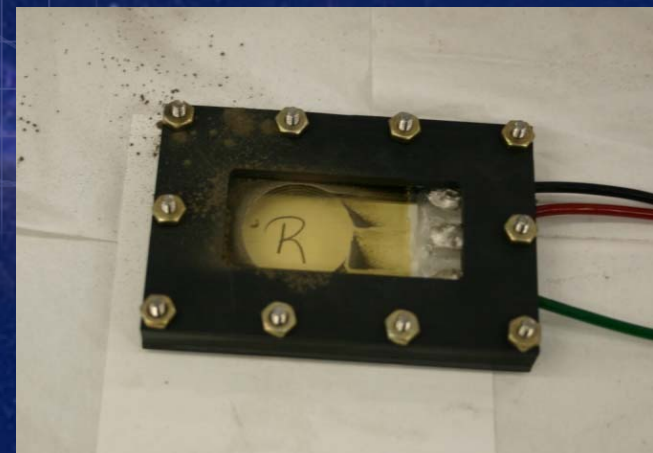
Specimen	As filled	Packed
Ilmenite 50-75 μm	5.74	5.86
Spodumene 50-75 μm	3.07	3.19
Olivine 50-75 μm	2.67	2.83
Feldspar 50-75 μm	2.19	2.26

Developing video and Raman screens for the RESOLVE Lunar Rover Demo

- Working with LaRC in developing coatings for the screens
- Video screen will be LaRC's stack layer of polyimide topped with SiO_2
- Testing accomplished
- Water tightness - Screen ran continuous for 8 hours in ambient air and humidity
- 10-50 micron JSC-1A was dusted at 15 minutes intervals-Screen continued to clear - no breakdown or performance degradation
- Single Phase screens have been developed and tested
 - Move less than 10 micron JSC-1A in vacuum ($\times 10^{-5}$ torr) with no coating



RESOLVE video screen dusted with JSC-1A in air



*RESOLVE video screen after applying 10 Hz and 600V
("R" is to show the clarity of the coating after operation)*

They have ESD concerns with the replacement of an LVPS-2 board. ESPL will address these issues through high vacuum simulation testing



ESPL is testing the triboelectric properties of Space suit materials to estimate the charge levels acquired during EVA's. The tests include measuring, for the first time ever, brush discharges that occur under high vacuum conditions.



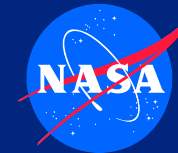
Cryogenics Test Laboratory

*Cryogenics Laboratory
Kennedy Space Center*

Notable Achievements

- Designed, developed and utilize a series of cryostats (Calorimeters) to determine the comparative and absolute thermal conductivity of insulation materials. Several provisional patents / patents have been filed for the cryostats.
- Designed, developed , fabricated and validated a Rapid Propellant Loading simulator / cryogenic test bed with flowrates up to 900 GPM @150 psig LN2.
- Designed, fabricated, tested and patented Robust MLI Insulation System.
- Fabricated test apparatus and performed the cryogenic testing in support of the resolution of STS-122/123 ECO Sensor failure / redesign and flight certification.
- Designed, fabricated, tested, and delivered an innovative cryogenic gate valve.
- Aided in the advancement of Aerogel silica based super insulation material for use in cryogenic and space applications.
- Designed, tested and validated an innovative Ground Umbilical Carrier Plate Disconnect Ice Suppression Shroud using Aerogel Blanket now being used for Shuttle Propellant Loading.
- Developed a magnetically coupled cryogenic pump satisfying a 15 year KSC high priority technology development need.

In Situ Propellant Conditioning



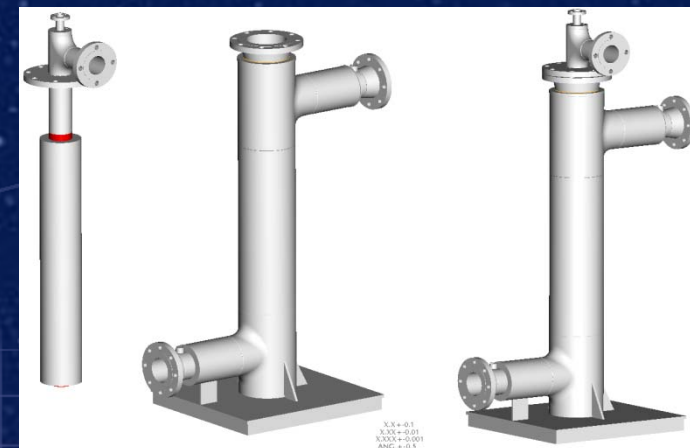
Project Purpose

Address Ares I LO2 Quality Issue

Low cost densification and conditioning

“Add-on” to existing transfer and storage systems (utilize existing infrastructure to reduce capital and maintenance costs.)

Scalable approach to provide passive quality improvement or active sub-cooling with same hardware (allows for tradeoff between cost and performance.)



Potential Uses

Improving quality of cryogenic propellant delivered to point of use.

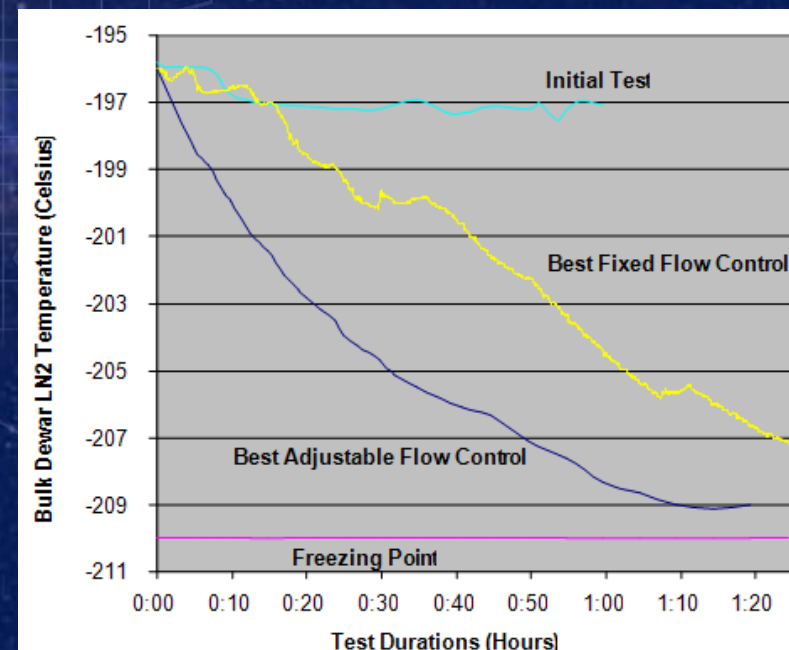
Preventing geysering in vertical cryogen transfer systems.

Providing densified propellant to launch vehicles.

Maintaining quality or densification in cryogenic storage vessels or flight tanks.

Capable of processing any cryogenic fluid.

Applicable to general industry as well as aerospace and defense.



Chilled Helium Heat Exchanger



Uses liquid hydrogen fuel to chill helium used for pressurization of flight tanks.

Being developed as an alternative to current chilled helium baseline design.

Aluminum foam construction allows very high heat fluxes, resulting in a compact and lightweight system.

Modular construction allows easy expansion of system if undersized.

Subscale testing with liquid nitrogen/gaseous helium is complete, heat fluxes as high as 500 W/in², averaged over entire transfer area.

Subscale testing with liquid hydrogen is scheduled October 2009 at NASA Plumbrook Station.



Heat exchanger being readied for upcoming LH₂ test.



Internal construction of subscale heat exchanger is two pieces of aluminum foam sandwiched between aluminum plates.

Design, fabrication and integration of Integrated Refrigeration and Storage (IRAS) prototype to characterize thermo-fluid behavior of liquid oxygen for Lunar Surface Applications.

The IRAS completed LN2 qualification boil-off testing to characterize the storage tank

Instrumentation was checked-out and repaired as required

IRAS has been tested with liquid oxygen with the LN2 heat exchanger at the located in the lower portion of the tank.

Heat exchanger will be relocated and the testing re-performed to find the optimal configuration for the storage tank.

The Propellant Scavenger task will demonstrate the ability to service and de-service cryogenic fluids.

Assembly and integration is continuing

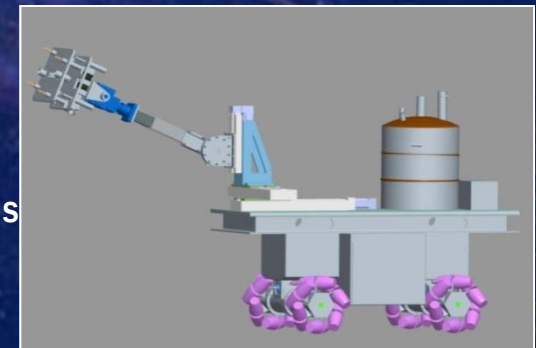
Wrist motor & joint manufacture and assembly is complete

Umbilical plate design substantially complete & fabrication will begin this quarter

Plan to demonstrate the ability to service and de-service cryo fluids this year

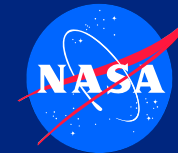


IRAS During Boil Off Testing



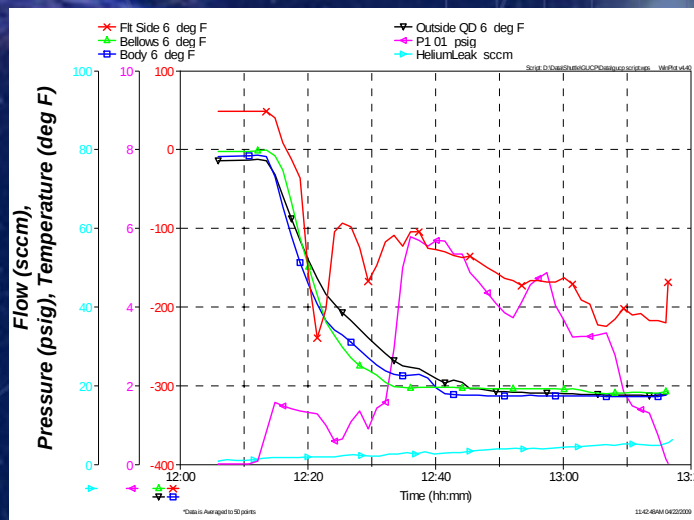
Propellant Scavenger Prototype

STS-119 GH2 Vent Cryo Leak Test



During the STS-119 launch attempt, a Hydrogen leak detected at the Ground Umbilical Carrier Plate (GUCP) resulted in a scrub. The QD and Flight Seal at the leaking interface were replaced and the assembly performed nominally during the next launch attempt.

The GUCP Leakage Anomaly Resolution Team requested a cryogenic leak test be performed on the suspect QD using the ET Test fixture assembly in attempt to recreate the conditions under which the leak was detected.



Cryo testing was performed on the assembly using GHe (25 psig), LN2 (25 psig) and LHe (6 psig).

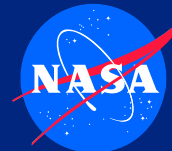
Leak rates detected under cryogenic conditions were well within QD leakage requirements.

QD testing has contributed to the closure of GUCP Anomaly fault tree blocks.

Due to limitations of the GFE LHe dewars, testing was unable to achieve desired pressures at the QD interface.

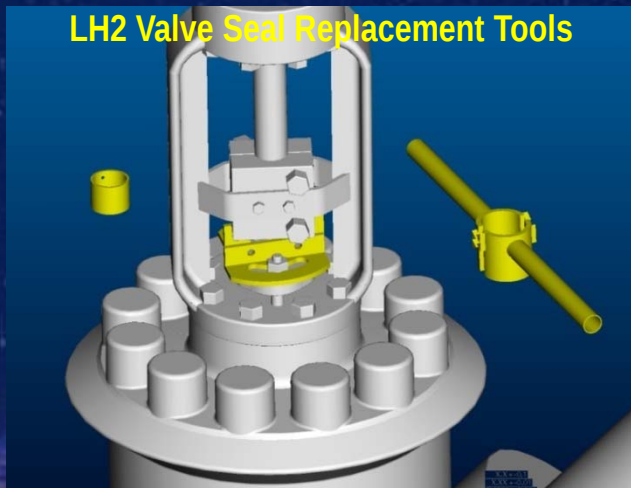
As predicted, due to the low heat of vaporization of LHe, testing was unable to achieve LH2 temperatures at the measured areas of the assembly.

Pad 39B LH2 Block Valve Refurbishment



Developing tools and tests to remove and replace or refurbish LC-39B LH₂ block valves without draining and inerting the LH₂ storage tank.

LH₂ Valve Seal Replacement Tools



4" LH₂ Valve Freeze Plug Testing



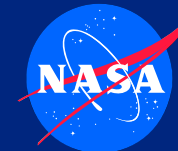
10" LH₂ Pipe Plug Testing



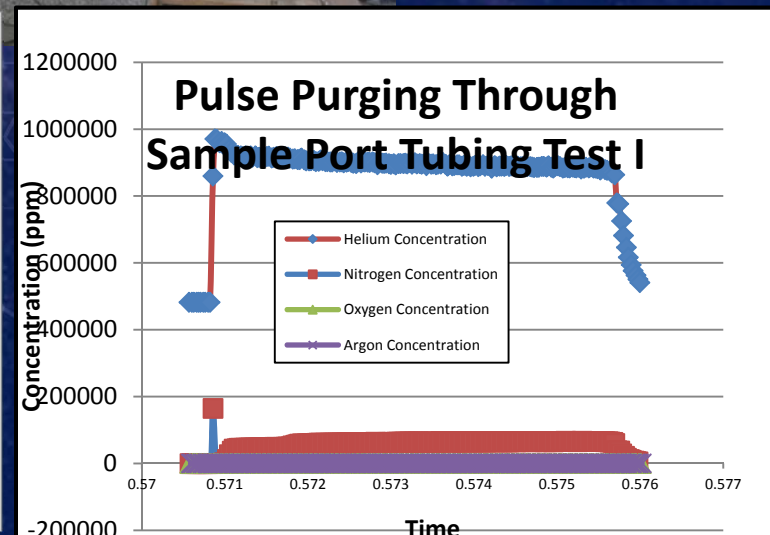
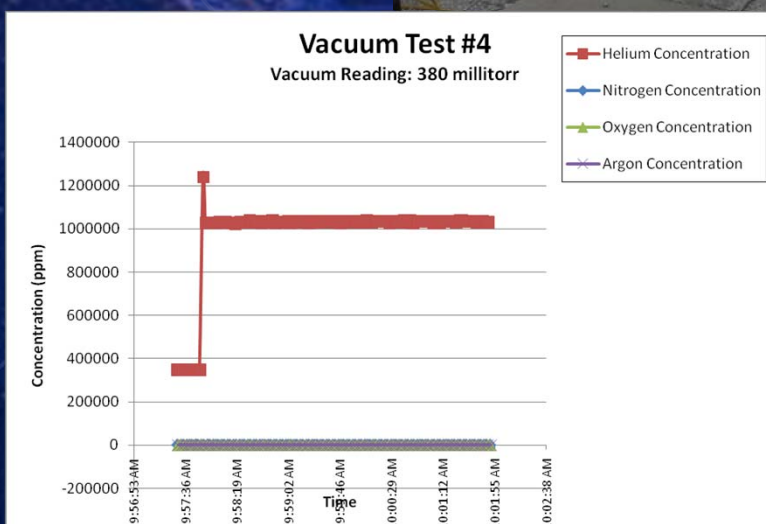
Sense Line Replacement Testing



Helium Conservation Testing



Performing purge tests (pulse purge, flow through purge, vacuum evacuations) to dry and inert a mock liquid hydrogen line using minimal gaseous helium





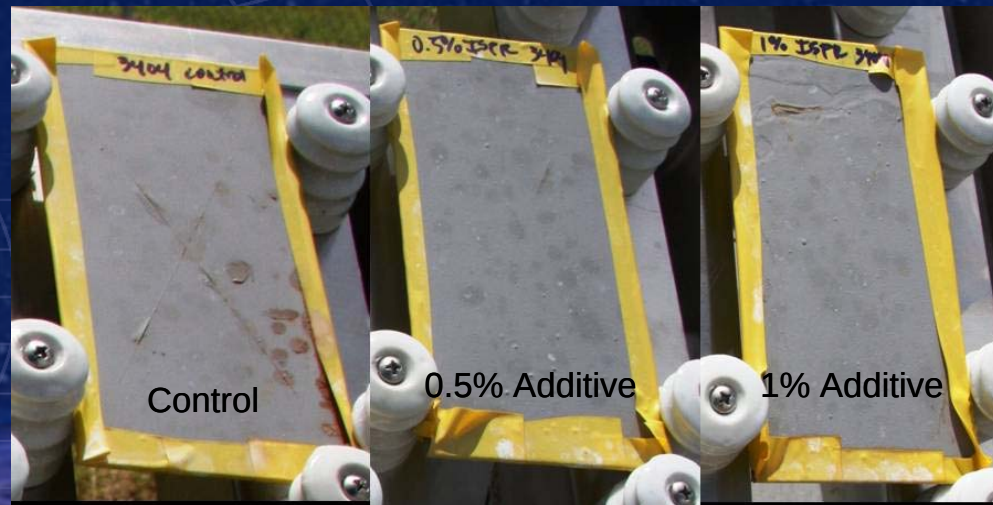
Corrosion Engineering and Technology Lab

*SLSL Building, Beach Site
Kennedy Space Center*



Adhesion problems of GE 3404
on flex hose.

Evaluated Panels at the Corrosion Test Site



After 2 months at beach with biweekly acid rinsing

Physical Endurance Tests on GE 3404 Panels

Evaluation of Bronz-Glow F884 altered coatings.

The only refractory material qualified for use at KSC is Fondu Fyre, which is supplied by the Pryor Giggey Co.

During launch, sections of this material have spalled and delaminated from the flame duct surface.

ASRC Corrosion Group provided reports investigating:

- A lifecycle cost analysis comparing current refractory materials with potential alternatives

- Refractory materials used in similar industries

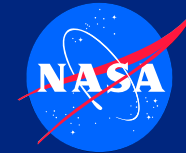
- The advantages associated with the “in-place” sintering of refractory materials

- COTS alternatives

- Alternative flame deflector designs



Lunar Simulant Sintering Evaluation

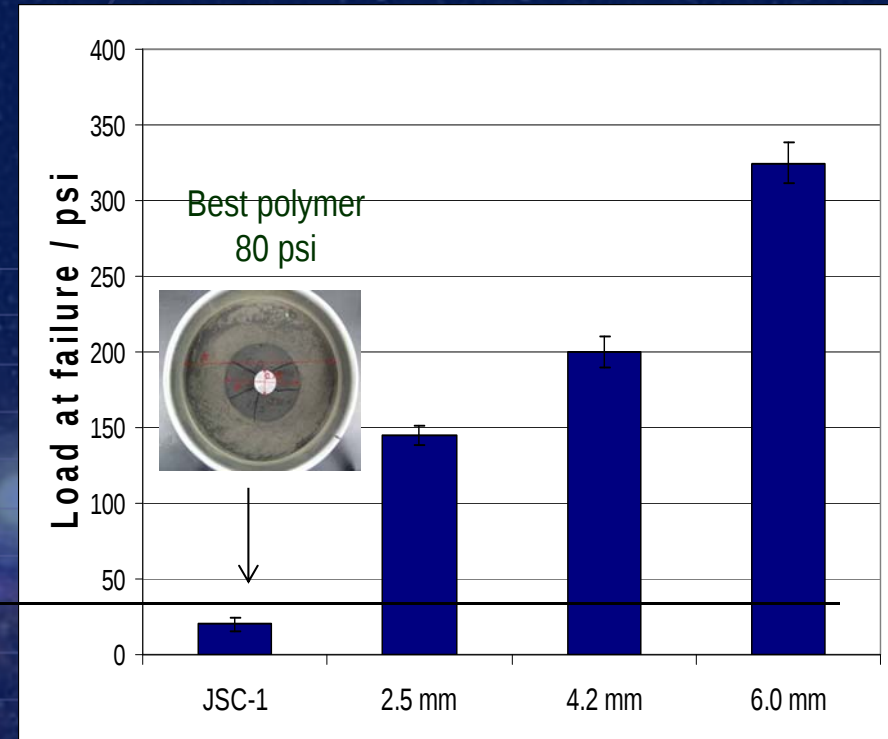


Evaluated 4 commercially available powder mixtures using sintered JSC-1 as control for:

- Abrasion
- UV resistance
- High temperature resistance
- Compression

Demonstrated stabilization in the lab and in the field using our solar concentrator

Investigated different spreading ratios, mixing ratios and application methods



Sintering Methods for Lunar Launch Pad



Regolith erosion observed at Apollo landing sites. Dust ejecta can be problematic.

Use sintering to solidify lunar regolith for building lunar launch pads.

Evaluate sintering methods using a solar concentrator and microwave heating.

The solar concentrator successfully heated JSC-1A to melting, and converted it to a glass. Sample heated for 8 minutes - melted in 1 to 2 minutes.

Basalt sample heated for 2 minutes in a crucible. The very top melted - sintered to about 1/4 inch depth.

Sinters very solidly at 1100° C in the vacuum furnace, and partially at 1000° C. It does not do as well in air. JSC-1 did not melt at any temperature.

Reusable lunar landing/launch pad that mitigates dust ejection necessary for successful completion of lunar base.



Solar Concentrator



JSC-1A

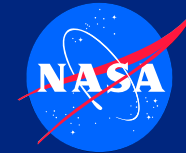


JSC-1A heated to 1100° C for 30 minutes in vacuum



JSC-1A heated to 1100° C for 30 minutes in air

LC39A Flame Trench Firebrick Adhesion



Failure of the epoxy bond between the refractory firebrick walls and the concrete substrate.

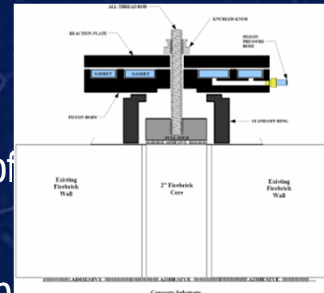
Provide method for determining adhesion strength of the firebrick wall to concrete substrate.

Evaluate areas of concern using standard ASTM lab methods for determining adhesion of coatings applied to concrete substrates.

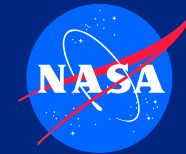
A testing procedure was developed which consisted of drilling a 2" I.D. core in the brick, attaching a adhesion dolly, and performing the pull tests.

In total, 18 cores where drilled. Of these, 50% of the cores where pulled away from the concrete backing wall during drilling. Adhesion testing of the remaining showed an average pull off tensile strength of 91.6 psi with the failure being at the outer surface of the firebrick. Each area tested showed positive adhesion using the hammer tap mapping technique.

Test results showed the hammer tap mapping methods used to determine adhesion loss were inconclusive.



An Analysis of Coating Degradation - U.S. Army Research Laboratory

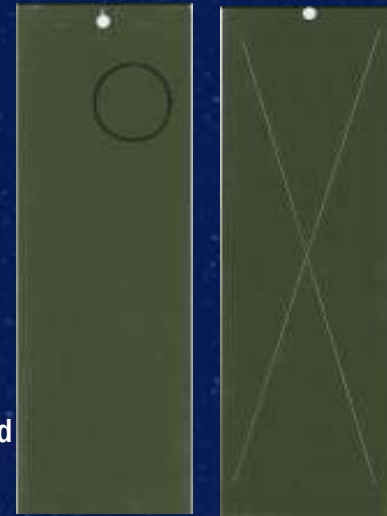


This project is evaluating the corrosion prohibiting performance of Chemical Agent Resistant Coatings (CARC).

Two identical sets of test panels were prepared. One will be exposed to a coastal atmosphere. The second set will be exposed to ASTM B117 salt spray testing.

Electrochemical Impedance Spectroscopy and physical methods of analysis will be used to quantitatively evaluate coating degradation.

Scribed and Non-Scribed
CARC Coatings

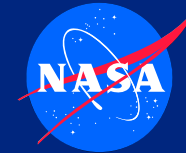


Gamry Potentiostat for Electrochemical Impedance Spectroscopy

Applied Physics Lab

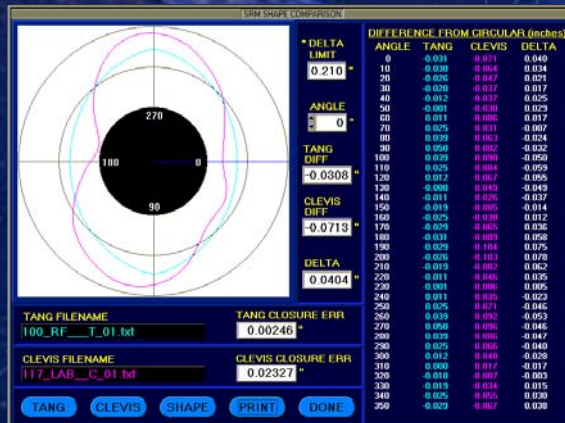
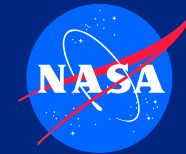
*O&C Building
Kennedy Space Center*

Shuttle Shop Aides and GSE



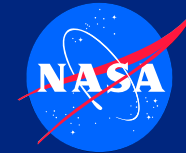
RMS Over-Center Measurement Verification Device

SRB Tools Circularity Measurement / Handling

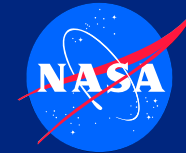


Solid Rocket Booster tools measure and control loading to meet circularity requirements for segment stacking

Access and Handling Systems



Hail Monitors



Automated Surface Observing System (ASOS) units are operated and controlled by the NWS, FAA and DOD.

Deployment of ASOS began in 1992 and completed in 2004.

Besides serving aviation needs, ASOS serves as a primary climatological observing network in the United States, making up the first-order network of climate stations.

Not every ASOS is located at an airport – some are for the sole purpose of providing climatological observations.

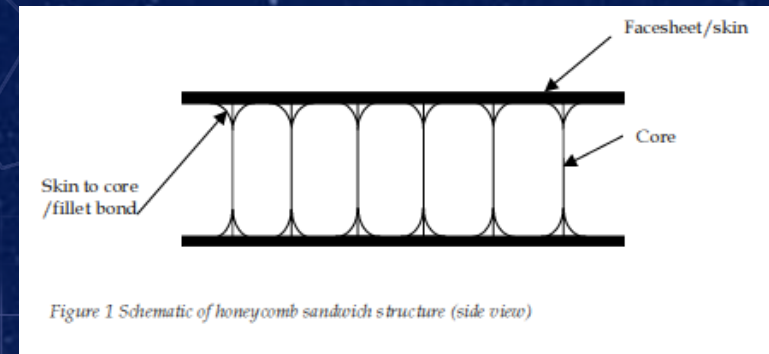
Automated airport weather stations are not yet able to report hail, ice pellets, and various other intermediate forms of precipitation.



NDE Techniques for Composite Fairings



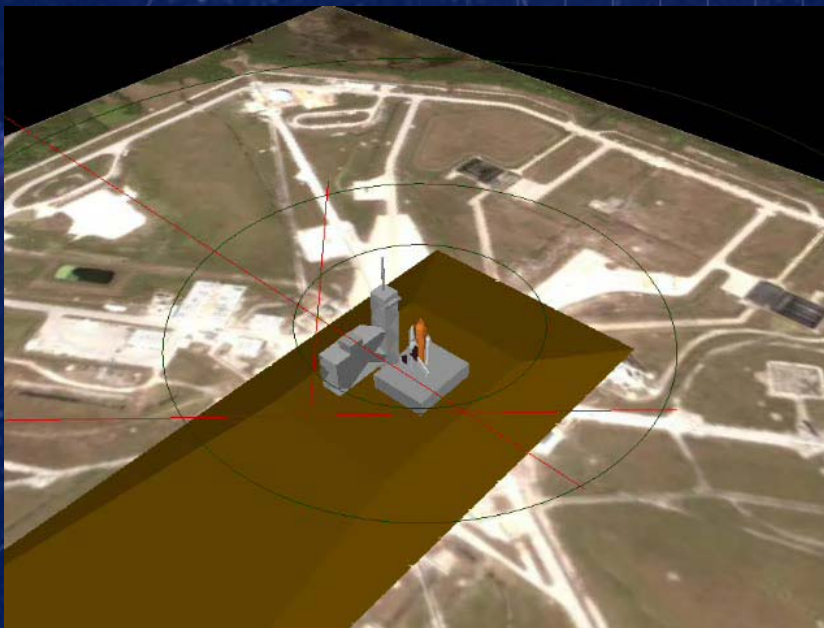
- Water ingress can be a major problem with composite sandwich structures
- Degrading the fillet bond between face sheet and core
- Delamination due to expansion during heating and cooling through steam or ice
- Corrosion of core material which can degrade strength of core and core to face sheet bonds
- Trapped water also adds to the overall weight of launch structures
- The current testing is investigating the migration of water ingress issues by creating a constant trickle purge of nitrogen through the structure which will protect the bond and core materials by removing all moisture from within the structure.



Test setup with Graphite Epoxy Aluminum Honeycomb composite panels built by ATK to be similar to proposed Ares V payload fairings

● Shuttle Launch Bird Vision System

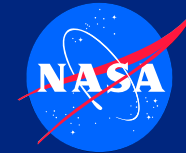
- This software provides real-time bird location data to the NTD's computer in the LCC Firing Room to view all triangulated intersections (birds) from any angle against a background map and 3D CAD model of Pad 39A.



Range Technologies Lab

*Engineering Development Lab
Kennedy Space Center*

Emerging Communication Technologies

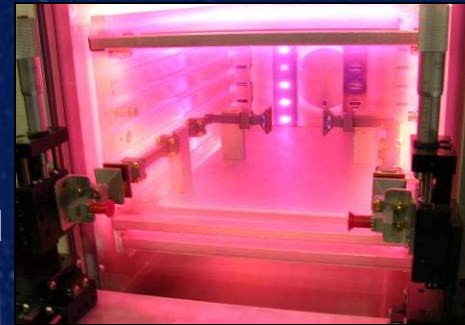


A 7-year (2002-2009) experimental applied research project in Millimeter Wavelength (MMW), Free Space Optics (FSO), Extended Range Wi-Fi (Wi-Max), Ultra Wideband (UWB) communication systems, and related spin-offs.

Extensive research/test results are available in 7 annual NASA Technical Memoranda, covering:

- MMW Comm thru Plasma,
- 60 GHz O₂ Absorption,
- FSO,
- Wi-Fi,
- UWB Comm./RF-ID,
- Wi-Max, etc

New Technology Reports (NTRs) for: Photonic Bandgap Technology, Detection of Non-Cooperative UWB Transmitters, and Non-Destructive Evaluation/Inspection of Corrosion Under Paint using millimeter wavelength focused energy

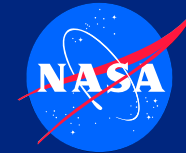


MMW Comm.
Through Plasma



24/7 FSO Testing

Shuttle Landing Aid Certification Tools



Differential GPS reference station

Automatic Flight Inspection System (AFIS) data downlink

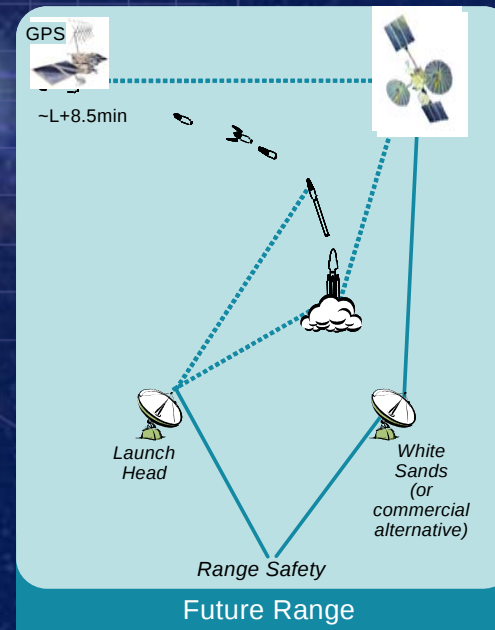
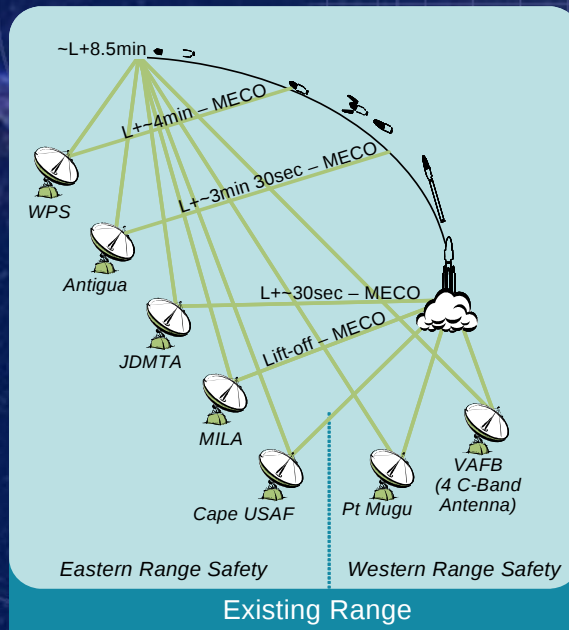


Microwave Scanning Beam Landing System (MSBLS) signal simulator



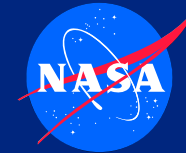


- STARS reduces the need for ground based range assets to:
 - Increase Range responsiveness
 - Increase Range capacity
 - Reduce the cost of operations
- STARS uses state-of-the-art communications systems and components:
 - Uses existing proven satellite systems (TDRS and GPS) to provide reliable communications and minimize risk to the flight demonstrations.



SBIRIL_004v2

Model-Based Diagnosis (MBD)



Software capability to recognize and adapt to failures in physical hardware

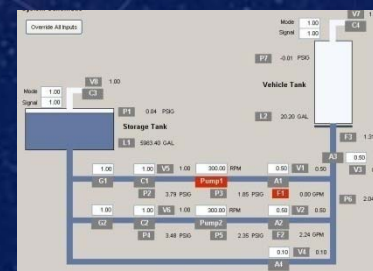
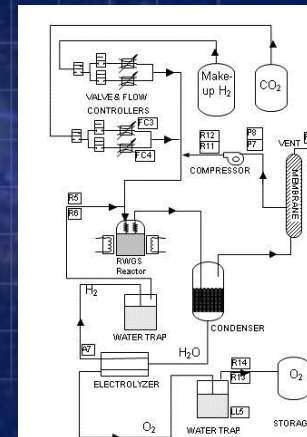
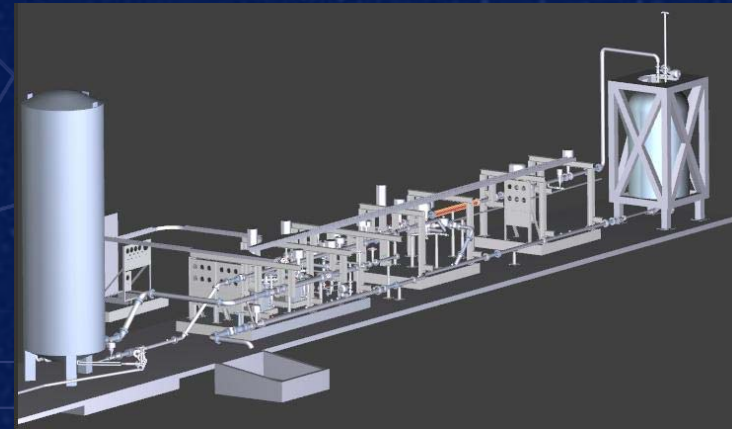
Advise operators of equipment faults and workarounds

Recover from faulty conditions via redundancy and reconfiguration

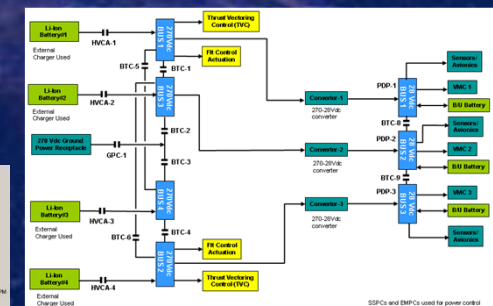
Useful for operator training, control advisories and Single-point Failure analysis

Generic MBD software + hardware model = comprehensive diagnostic capability

Applications:
Rapid Propellant Loading
Lunar Oxygen plant control
Thermal management
Electrical Power Distribution
Environmental control



Hardware model is easily constructed from a library of standard GSE and flight hardware components



Current Technology Evolution

